

COUNTY OF ALBANY

REQUEST FOR BIDS SHAKER PLACE NURSING AND REHABILITATION CENTER



RFB #2024-150

SHAKER PLACE CAFÉ PROJECT

VOLUME 3

**ALBANY COUNTY DEPARTMENT OF GENERAL SERVICES
PURCHASING DIVISION
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ALBANY, NY 12207**

**ALBANY COUNTY SHAKER PLACE REHABILITATION
& NURSING CENTER CAFÉ RENOVATION
ALBANY, NEW YORK**

October 6, 2023

OWNER

County of Albany
Shaker Place Nursing Home
Albany, New York

ARCHITECT

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Albany, New York 12206
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STRUCTURAL ENGINEER

MRH Engineering, P.C.
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Queensbury, New York 12804
(518) 792-4042

**MECHANICAL/PLUMBING/
ELECTRICAL ENGINEER**

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Clifton Park, New York 12065
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PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.02 ALLOWANCES, ALTERNATES AND UNIT PRICES

- A. Refer to Division 1 specifications for allowances, alternates and unit prices required as part of this Contract.

1.03 INTENT

- A. The intent of the drawings and these specifications is to provide all systems complete and operative. Whether indicated on the drawings and/or included in the specification or not, provide all materials, equipment and labor usually furnished with such systems.

1.04 DEFINITIONS

- A. Provide: Furnish, install and connect.
- B. Furnish: Supply material only.
- C. EXR: Existing to remain.

1.05 SCOPE OF WORK

- A. Drawings and specifications are complementary and must be so interpreted to determine the full scope of work under this section. Wherever any material, article, operation or method is either specified or shown on the drawings, this Contractor is required to provide each item and perform each prescribed operation according to the designated quality, qualification or condition, furnishing all necessary labor equipment and incidentals.
- B. Specifically included, without limiting the generality of drawings and specifications are:
 - 1. Plumbing fixtures and trim indicated.
 - 2. Valves where indicated.
 - 3. Connection to equipment "by others" as indicated.
 - 4. Hot and cold water lines, recirculating lines.
 - 5. Sanitary drainage and vent lines.
 - 6. Connection to existing water and sewer mains.
 - 7. Thermal insulation on hot and cold water systems.
 - 8. Remove existing plumbing fixtures where indicated.
 - 9. Remove existing plumbing piping systems and equipment where indicated.
 - 10. Sprinkler system.
 - 11. Tests: This contractor shall furnish materials, equipment and labor and shall perform all work of testing of the plumbing systems as outlined hereinafter. Testing procedure shall include installation tests and operating tests.

1.06 TEMPORARY SERVICES

- A. Temporary Heat: In accordance with Architect's specifications and/or conditions, contractor shall have the permanent heating system capable of providing heat to the new work areas when required. The term heating system shall include all work or components necessary to operate heating system. For temporary usage, it is not required that this work be in a finished condition, i.e., covers in place, etc. Cost of fuel consumed for temporary heat from permanent systems only shall be paid by owner.
- B. The use of permanent system will be allowed only if the building is fully enclosed with no construction dust to clog heating/cooling coils, heat recovery components, fans, etc.
- C. At the completion of work, Contractor shall turn over to the Owner all equipment used for temporary heat in a new, as purchased condition. Contractor shall replace filters with new ones, clean all components which shall include: unit casings, ductwork, grilles, diffusers, etc., re-lubricate all moving parts, replace belts if required and perform any other work necessary (as determined by Architect and Engineer) to put equipment in a "new" condition.
- D. Contractor shall take all measures necessary to insure that dust, dirt, or debris does not enter air systems while in operation for temporary heat and shall change filters as often as necessary. Under no circumstances shall air handlers be allowed to operate with no filter in place.

1.07 CONTINUITY OF UTILITY SERVICES

- A. It is of paramount importance that each utility service operate continuously and without interruption. Whenever this contractor plans to make changes or alterations to any existing utility service, such plans shall result in no or minimum service interruption or inconvenience to Owner. This contractor shall plan and schedule any change or alteration to an existing utility service with Architect and Owner. Such planning, timing, and/or scheduling shall be approved by both these parties.

1.08 CODES AND STANDARDS

- A. All materials, equipment, and installations by this contract shall be in accordance with the latest editions of the following applicable requirements:
 - 1. 2020 International Building Code, including all applicable amendments supplements to the following:
 - a) 2020 International Building Code
 - b) 2020 International Existing Building Code
 - c) 2020 International Fire Code
 - d) 2020 International Plumbing Code
 - e) 2020 International Mechanical Code
 - f) 2020 International Fuel Gas Code
 - 2. 2020 Supplement to the New York State Energy Conservation Construction Code including all applicable amendments to the following:
 - a) 2020 International Energy Conservation Code
 - b) 2020 ASHRAE 90.1
 - 3. 2020 Uniform Code Supplement (May 12, 2020)
 - 4. Lead testing in school drinking water (10 CRRNY 67-4)
 - 5. Conform to requirements of NEMA.
 - 6. Liquefied Petroleum Gas Code - NFPA 58.
 - 7. Bear label of Underwriters Laboratories, Inc.
 - 8. National Electrical Code NFPA Article 70, latest edition.
 - 9. New York State Health Code.

10. Local Utility Standards.
11. Local Municipal and/or City Standards.
12. Industrial Code Rule #4 and #14 (12NYCRR 4 and 14) (Standards for Boiler Installation).
13. Conform with applicable requirements of ASTM - Regulations and Standards for Pipe and Pipe Fittings.
14. Be in accordance with USAS - Code for Pressure Piping, latest edition.
15. For external and internal pipe insulations, have flame spread rating of 25 or less and smoke developed rating of 50 or less when tested in accordance with ASTM Standard E84.
16. Sheetmetal and Air Conditioning Contractor's National Association, Inc. (SMACNA), latest editions.
17. Conform with applicable requirements of Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A, and Code for Safety to Life from Fire in Buildings and Structures, NFPA 101.
18. Be in accordance with design standards outlined in ASHRAE Handbooks, latest edition.
19. Conform to requirements of Owner's insurance carriers.

1.09 SUBMITTALS AND SUBMISSION REQUIREMENTS

- A. All submittals shall be in accordance with Division 1 requirements, the following requirements listed below, and also as indicated in each specification section. All submittals not complying with the listing above will be returned to the contractor without being reviewed. Rejection by Architect or Engineer of any items submitted shall require resubmittal of acceptable items.
1. Within (30) days after receiving signed contract or notice to proceed, submit to Architect for review complete descriptive dimensional data and ratings for equipment and materials proposed to be furnished and installed. Submit (8) copies of data unless otherwise specified by the architect.
 2. All materials submitted shall clearly state the job name and specification section(s) that it applies to.
 3. Any package containing more than one piece of equipment or material shall also contain a schedule clearly listing all items in submittal. Schedule page(s) shall also indicate project name and building name.
 4. All submittals must be clearly marked using nomenclature used in this specification for proper item identification, schedule of usage's, model numbers, construction materials, performance, data, etc.
 5. Projects involving multiple buildings must have the submittals separated by building. Submittals in which buildings are combined will not be accepted. (Exception: When specifically approved by engineer, basic materials may be submitted once.)
 6. The contractor shall verify and insure that dimensions and elevations of equipment and structures to be used conform to the space allocated for the equipment on the drawings, and complies with existing conditions.
 7. Submittals traced or copied from contract drawings are not acceptable and will be returned without review.
 8. In the event material and/or equipment is installed prior to obtaining approval of shop drawings, and in the sole opinion of the Owner's Agent, this material and/or equipment does not meet the specifications, the Contractor shall be liable for the removal and the replacement at no additional cost to the contract.

- B. Samples: When requested by Engineer, provide samples of both specified equipment and proposed substitutions for review by the Owner's Agent. Such equipment shall be delivered to a location designated, or erected at the job site as directed. When neither is physically possible, arrange for the Owner's Agent to visit an acceptable site where the proposed equipment can be inspected.
- C. Substitutions:
 - 1. Submittals for equipment or materials other than as specified shall be accepted for review by the Owner's agent.
 - 2. Approval of substitute equipment shall be based on functional, physical and aesthetic compatibility to the equipment specified as determined by the Owner's agent and approved by the engineer.
 - 3. Where substitute equipment is approved, the contractor shall be responsible for, and bear the cost of any necessary changes by his trade or other trades to make the system complete and operable.
 - 4. Contractor is fully responsible for providing coordination between all trades affected by equipment substitution.
 - 5. When requested, contractor shall submit layout drawings indicating new dimensions and arrangements of substituted equipment. Layout drawings shall indicate all revisions necessary for all services affected by substitution.

1.10 SUBSTANTIAL COMPLETION REQUEST FOR PUNCH LIST

- A. Contractor shall submit a letter in email form stating that the work is substantially complete and ready for Punch List review by Engineer.
- B. Contractor shall note which areas are substantially complete by Building (if multiple buildings) and by Area according to the Key Plan.
- C. Contractor shall list all items that are known to be incomplete at time of submission.
- D. If the request is for a partial Punch List, Contractor shall also include a list of room numbers/room tags.
- E. When letter is received by the Engineer, site review(s) will be coordinated with the Construction Manager, Clerk, Architect.

1.11 CUTTING AND PATCHING

- A. This contractor shall bear the cost of all cutting and patching required by and for the installation of this work. This contractor shall perform all cutting and patching unless otherwise indicated on drawings or if directed by the Architect.
- B. Patching of fire rated floors, walls, partitions, etc. shall be made using new materials equal to the fire rating of the existing.
- C. Should changes, omissions or errors in this contract's work require cutting, patching or making alterations in any portion of new construction, such work will be performed by GC at this Contractor's expense.

- D. Cutting and patching of roof surfaces and structures shall only be performed by a qualified contractor, as approved by the Architect. The work of this contract shall bear the cost of above mentioned cutting and patching. This contractor shall insure that existing roof warranties remain in force.
- E. This contractor shall furnish lintels, sized to accommodate structure above opening, where cutting and patching is to be performed on load bearing walls. Contractor shall obtain written approval for all lintels prior to installation.
- F. Cutting shall be done in a manner which will not adversely affect the strength of the building. Holes and openings shall be neatly cut so as to provide a finished appearance and shall be patched around the edge where required for a finished appearance. Provide temporary bracing, shoring, etc. as required.
- G. Patching shall be structurally sound and match the existing materials and finish of adjacent materials. Patching is required in finished areas, wherever existing work is removed, at the sides of openings, etc.
- H. At the completion of the work, all evidence of alteration will be as inconspicuous as possible.

1.12 FIELD INSPECTION

- A. As there are various conditions at the site which do not show on the accompanying drawings, or which are at variance with the conditions indicated on the drawings, it is important that each bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.
- B. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.13 INSTRUCTION SERVICES AND MANUALS

- A. Instructions:
 - 1. Provide competent personnel to remain at the jobsite for necessary time to instruct the Owner's personnel in proper operation and maintenance of installation made by this contractor.
 - 2. This contractor shall be responsible for notifying and instructing Owner's personnel on all equipment operations, maintenance requirements, etc. Furnish operating training session(s) for equipment listed.
 - 3. The Owner shall be responsible for establishing an operating and maintenance program for all equipment listed.
- B. The instruction shall include the following types of information:
 - 1. System overview
 - 2. Major component designation
 - 3. System operation procedures
 - 4. Maintenance scheduling and procedures
 - 5. Provide a list of spare components each system would normally require

- C. Services: Provide services required, for all equipment specified under this contract, for a period of (1) year after written acceptance by the Owner.
- D. Manuals: Submit (3) sets of Operation and Maintenance manuals. Each set shall contain the manufacturers' data, operating instruction parts catalog and maintenance procedures for each piece of equipment. Include normal maintenance servicing schedule to be performed by the Owner.
 - 1. For projects containing multiple buildings, manuals shall be submitted separately for each building.

1.14 PERMITS, CERTIFICATES AND FEES

- A. This Contractor shall obtain and pay for permits, certificates, fees etc. listed below. Costs for permits, fees etc. shall be included in the Base Bid amount.
 - 1. All required applications and permits to begin work
 - 2. Certificate of inspection including Third Party Agent
 - 3. All municipal connection charges
 - 4. All local utility charges (gas etc.)
 - 5. Fees and charges shall be obtained directly from the respective authority having jurisdiction.

1.15 REMOVAL, DISPOSAL AND HAZARDOUS MATERIALS

- A. All removed equipment shall be removed from the site and properly disposed of.
- B. All hazardous materials must be disposed of in compliance with ENCON and all other regulatory agencies.
- C. The Owner may wish to keep certain equipment, therefore, check with Owner before removals to determine what may be salvageable.

1.16 GAURANTEE

- A. Contractor shall guarantee all work furnished through this contract including work performed by sub-contractors, for a period of (1) year (unless otherwise noted), from the date of final acceptance. Contractor agrees to repair or replace any defective work or materials at no additional cost to the Owner. Contractor shall also pay for any damage to other work resulting from repairs to defects. Contractor shall furnish written guarantees to the Owner's agent in accordance with the general conditions.

1.17 INSTALLATION

- A. This contractor shall coordinate scheduling and installation of work with other contractors, sub-contractors and other trades. The contractor is also required to coordinate all work with owner supplied materials, direct contracts, and normal building operations, if any.
- B. All finished work shall be neat and workmanlike. All work of a special nature shall be performed by skilled and qualified workmen who can present credentials showing experience in said trade. New systems shall be delivered to Owner complete in perfect working order, tested and balanced in full accordance with plans and specifications. Existing systems shall function in same manner as before this work was performed. Any malfunctions which arise in existing systems as a result of demolition or alteration of parts of such systems shall be corrected.

- C. Layout of equipment, accessories and piping systems in plan is generally diagrammatic unless specifically dimensioned or detailed. Check project drawings and existing site conditions before installing work for interference's as governed by structural or other conditions. Owner reserves the right to make reasonable changes in location of equipment, accessories or piping systems prior to "roughing-in" without involving additional expense. Exact dimensions shown upon plans will be subject to verification and confirmation of exact conditions at site at time of construction. "Plus or minus" dimensions are shown upon drawing as a guide only. Exact surrounding conditions are governed by final equipment selection and/or other like details.
- D. Furnish all new equipment and materials as described herein. Any material, operation, method or device mentioned, listed or noted within this specification, if not specifically mentioned as furnished or installed by others, shall be furnished and installed by this contractor.

1.18 TESTING AND INSPECTION

- A. Inspections required for any ordinances, regulations, instructions, laws, rules, standards and practices that require any work to be inspected or tested shall be performed. Contractor shall give Owner, Architect and Engineer timely notice of readiness of work for inspection or testing and the date fixed for said inspection or testing.
- B. Third-Party Agency must inspect completed installation and present Owner with Certificate of Inspection showing approval.
- C. Required local or municipal inspection processed and present Owner with certificate indicating approval of such governing bodies.
- D. Contractor shall submit a written report to Architect, copy to Engineer, on results of each inspection or test on system or equipment supplied. Report shall contain all pertinent information, recommendations, approvals, additional work required, etc.
- E. Tests:
 - 1. After installations are completed and before insulation is applied, walls are closed, or trenches backfilled, all portions of the installation shall be tested in accordance with the procedures described herein.
 - 2. Provide hydrostatic pressure test for storm water sanitary and vent pipe with 10' or more developed length. Test pressure shall be a minimum of 10' water column at all points except the upper most portion of the roof vent or drain terminal. Piping shall be tested in sections with approved test plugs, duration of the test shall be one hour. In addition to the pressure test described above, Contractor shall provide a flow test for each section of the plumbing drainage systems to verify that there are no blockages. All pipes must be exposed during testing unless otherwise approved by Engineer.
 - 3. Interior domestic water piping shall be tested at 125 psi pressure. Contractor shall fill piping at the beginning of working day and maintain pressure for two hours with no pressure loss. If no leaks are found, the piping shall be allowed to remain under pressure overnight and then be inspected the next morning. No insulation shall be applied to the piping until the test is complete.

1.19 RECORD DOCUMENTS

- A. When required by general conditions or other Division 1 Section this Contractor shall prepare and turn over to Owner's agent record As-built documents. As-built drawings will include actual equipment location layout, service connections, ductwork and piping layouts, valve locations, etc.
- B. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

1.20 IDENTIFICATION AND NAMEPLATES

- A. Provide engraved plastic labels screwed to equipment furnished under this contract including control panels, starters, switches, panels, etc. Labels shall have black background, white letters; minimum letter height 3/8" high, self adhesive labels or punch tape type labels are not acceptable.

1.21 PENETRATIONS THRU FIRE RATED CONSTRUCTION

- A. All penetrations by this contract through rated construction shall be sealed fire safe by a UL listed approved method.
- B. All piping penetrations through walls, floors, etc. shall be sleeved.
- C. All piping penetrations through fire rated partitions, walls, floors, etc. shall be installed as follows; penetration shall be oversized 1/2" to 3/4" maximum. This contractor shall pack with fireproofing insulation, type FS cerablanket. Outside of penetrations (exposed surfaces around pipes and ductwork) shall be caulked and sealed with flame stop V, as manufactured by Flame Stop, Inc.; or an approved equal. Flame stop sealant shall be troweled smooth for finishing as required.

1.22 CONFINED SPACES

- A. All work in pipe tunnels, mechanical pits, well manholes, etc. shall be performed by skilled tradesman and laborers with current certification for working in confined space. Contractor shall bear all costs to provide all safety equipment, ventilation, etc. as required by State and Federal Regulations and shall obtain all necessary permits for such work.
- B. Contractor shall submit copy of current certifications and photo I.D. of all tradesman and laborers who will be working in confined spaces on this project.

1.23 COORDINATION DRAWINGS

- A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings at not less than 1/4" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings as follows:
 - 1. HVAC Contractor will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by

the Owner and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.

2. HVAC Contractor will provide prints and CAD drawings and submit the base plan to all major trades' Contractors.
3. Electrical, Plumbing and Fire Protection Contractors will draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.

END OF SECTION 22 0010

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1 Specifications Sections, apply to the work of this section.
- B. Entire sprinkler system shall be designed to be in compliance with NFPA 13 and shall be approved by the Owners Insurance Underwriter prior to installation.

1.02 SUBMITTALS

- A. All items specified in this section.
- B. Prior to purchasing any equipment or materials, a list of their manufacturers shall be submitted.
- C. Scale drawings indicating invert and sleeve locations, stamped by a Professional Engineer.
- D. Scale drawings showing all piping with sizes, elevations and appropriate indication of coordination with other trades, dimensioned location of each sprinkler head, approval stamp of governing authority.
- E. Catalog information, factory assembly drawings and field installation drawings as required for a complete explanation and description of all items of equipment.
- F. Documents Will Not Be Accepted for Review Unless:
 - 1. They include complete information pertaining to appurtenances and accessories.
 - 2. They are submitted as a package where they pertain to related items.
 - 3. They are properly marked with service or function identification as related to the project, where they consist of catalog sheets displaying other items which are not acceptable.

1.03 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARDS

- A. Applicable Publications: The following publications form a part of this specification.
 - 1. No. 13 Sprinkler System
- B. The drawings and information included in this specification are given as a guide only, and they, therefore, do not relieve this Contractor from providing all work and equipment necessary to complete the installation according to the requirements. The number and spacing of sprinkler heads, spacing and size of pipe, location and number of valves, methods of draining lines, alarm valves and all other details and work shall be as required by the ISO, Owner's Underwriters', NFPA, local authorities and all other governing authorities.
- C. In general, sprinklers are to be arranged for coverage in accordance with NFPA #13 for The hazard classification, shown on the plans and hydraulically designed with a uniform density. Variation in discharge from individual sprinklers shall not exceed 15%.

1.04 LAYOUT

- A. Sprinkler heads shall be installed symmetrically, centered in ceiling tiles and coordinated with ceiling light fixtures, diffusers, ductwork, etc.

1.05 FIELD INSPECTION

- A. As there are various conditions at the site which do not show on the accompanying drawings, or which are at variance with the conditions indicated on the drawings, it is important that each bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.
- B. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.06 CODES, PERMITS AND INSPECTIONS

- A. All work shall meet or exceed the latest requirements of all national, state, county, municipal and other authorities exercising jurisdiction over construction work at the project.
- B. All required permits and inspection certificates shall be obtained, paid for, and made available by the contractor at the completion of the work.
- C. Any portion of the work which is not subject to the approval of an authority having jurisdiction, shall be governed by the applicable sections of the overall National Fire Code, as published by the NFPA.
- D. Installation procedures, methods, and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Act (OSHA).

1.07 GUARANTEES AND CERTIFICATES

- A. All work shall be guaranteed to be free from leaks or defects. Any defective materials or workmanship as well as damage to the work of all trades resulting from the same shall be replaced or repaired as directed for the duration of stipulated guarantee periods.
- B. The duration of guarantee period following the date of acceptance of the work, shall be (1) one year.
- C. The date of acceptance shall be the date of the final payment for the work or the date of a formal notice of acceptance, whichever is earlier.
- D. Non-durable replaceable items do not require replacement after the date of acceptance. If received in writing, requests to have earlier acceptance dates established for these items will be honored.
- E. Certification shall be submitted attesting to the fact that specified performance criteria are met by all items of equipment.

1.08 RECORD DOCUMENTS

- A. When required by general conditions or other Division 1 Section this Contractor shall prepare and turn over to Owner's agent record As-built documents. As-built drawings will include actual equipment location layout, service connections, ductwork and piping layouts, valve locations, etc.

- B. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

PART 2 - PRODUCTS

2.01 PIPING & EQUIPMENT/SPRINKLER & ALARM EQUIPMENT

- A. Products of The Viking Corp., Reliable Sprinkler Corp, Grinnell Co., Inc. or other "equal" manufacturer selected from "List of Approved Equipment and Materials" published by Factory Mutual and shall bear UL approval stamp or label, where applicable. Piping and equipment shall also be listed by a testing agency.

2.02 PIPE, FITTINGS, HANGERS & ESCUTCHEONS

- A. Pipe: All piping material shall be Black Iron according to ASTM A-120 with 1", 1-1/4", 1-1/2", 2", 6" and above being Schedule 40 and 2-1/2" thru 5" being Schedule 10 ASTM A135. As manufactured by Wheatland Tube and US Steel.
- B. Fittings: Pipe 1" thru 2" threaded malleable iron Class 150, ANSI B1603. Pipe 2-1/2" thru 6" threaded malleable iron or Victaulic Quick Vic Rigid Coupling Style 107 for grooved end pipe with ductile iron housing enamel coated and grade EHP-EDPM.
- C. Hangers: All hangers shall and installation shall be in accordance with the requirements of Section NFPA 13 section 3-15. Provide longitudinal and lateral sway bracing. Provide welded flanges on riser at each floor AWS D10.9; Level AR-3.
- D. Escutcheon Plates: At pipe penetrations through wall (Where piping is exposed) provide heavy gauge chrome escutcheons with springs, snap/split retro fit.

2.03 VALVE SEALS, SIGNS, TAGS & CHARTS

- A. Seals: Provide brass cross-link chain, all brass padlock, with keys, copper wire and approved seal, for each manually operated shut-off valve required to be sealed in open position.
- B. Signs: Provide identification signs of standard design, fasten securely at designated locations as per requirements of insuring agency. This shall include "When bell rings...", hydraulic calculation signs, and Inspectors test.
- C. Tags: Provide brass tags about 2" in diameter; stamp with designating numbers, secure 12 gauge copper wire to spindle of all control valves.
- D. Charts: The Contractor shall provide two (2) copies of approved sprinkler system diagram and valve charts giving designating number, function, location of each valve, mounted in painted, glazed frames, hung where directed.

2.04 SPRINKLER HEADS

- A. Provide approved automatic spray sprinkler heads, Reliable Sprinkler Corporation; or equal.
- B. Provide heads and type as scheduled on the plans.

- C. Provide stock of six (6) extra sprinkler heads of each type with cabinet, two (2) sprinkler wrenches in accordance with NFPA Pamphlet No. 13.
- D. Style and finish of sprinkler heads must be selected and approved by the Architect. Submit one (1) sample of each head.

2.05 TEMPORARY PLUGGING

- A. At times when pipe laying is not actually in progress, the open ends of the pipes shall close temporarily with pipe plugs or by other means. If water is in the trench when work is resumed, the trench shall be dewatered and the plugs shall not be removed until all danger of water entering the pipe is past.

2.06 CLEANING LINES

- A. At the conclusion of the work, the Contractor shall thoroughly clean all new pipes by flushing with water or other means to remove dirt, stones, pieces of wood, etc. which may have entered during the construction period. If, after this cleaning, any obstructions remain, they shall be removed to the satisfaction of the Engineer and/or Water District. Pipes shall be flushed at a rate of 2.5' per second for a duration suitable to the Engineer and/or the Water District. The rates of flow required to produce 2.5' per second flushing velocity in different sizes of pipe are as shown in the following table:

Pipe Size (Inches)	Flow Required to Produce 2.5 FPS Velocity (Gallons per Minute)	Hydrant Opening Required At 40 PSI Residual
4	100	One - 2-1/2"
6	220	One - 2-1/2"
8	390	One - 2-1/2"

2.07 HYDROSTATIC TESTING

- A. Testing shall be done within 72 hours of conclusion of installation.
- B. Hydrostatic acceptance tests, consisting of a pressure test and a leakage test, shall be performed on all sections of all water systems installed after the trench has been backfilled. Hydrostatic presumptive tests may be performed when the system is partially backfilled to simply check the work, but acceptance of the system shall be based on hydrostatic test runs on the finished system after it is completely backfilled. All hydrostatic tests shall be performed in accordance with Section 4 of ANSI/AWWA C600-82.
- C. For the pressure test, the system shall be pressure tested by pressurizing to a minimum of 150 pounds per square inch, based on the elevation of the lowest point in the section under test and corrected to the elevation of the gauge. Provisions shall be made to relieve air trapped at high points in the system adjacent hydrants or through taps and corporations stops installed for this purpose by the contractor. After this pressure has been maintained successfully, with further pumping as required, for a period of at least (1) hour, the section under test shall be considered to have passed the pressure test and leakage tests shall then be performed.
- D. Leakage tests shall be performed under a minimum test pressure of 150 pounds per square inch, based on the elevation of the lowest point of the section under test and corrected to the elevation of the gauge. The test section should be limited to a maximum length of about 2000'. The leakage test duration shall be a minimum of two hours after the leakage rate has been stabilized.

- E. The maximum allowable leakage for a (2) hour test per 1000' length of different sizes and nominal laying lengths of pipe shall be as shown in the following table:

Pipe Size (Inches)	Allowable Leakage at 150 PSI (Gallons per 2 Hours per 1000' of Pipe)
3	0.56
4	0.74
6	1.10
8	1.48

- F. All water for tests shall be furnished and disposed of by the Contractor at his own expense. Source and/or quality of the water which the Contractor proposed to use in testing the lines shall be acceptable to the Water District.

2.08 STERILIZATION

- A. All pipes and fittings connected to and forming a portion of a potable water supply shall be sterilized and flushed in a manner acceptable to the Engineer and/or Water District. Sterilization shall be accomplished after the pipe has passed the pressure and leakage tests.
- B. Sterilization shall be performed in accordance with ANSI/AWWA C601-81 (excluding section 5.1 covering the tablet method).
- C. Sterilization shall be accomplished by applying a chlorine solution that will give a 50 ppm chlorine residual throughout the main being disinfected. The chlorine solution shall remain in the water mains for a minimum period of (24) hours. At the termination of this period, the chlorine residual shall be a minimum of 25 ppm. If the residual is less than 25 ppm, the entire procedure shall be repeated. The chlorine solution shall be thoroughly flushed out prior to placing the new section of the main in service. The chlorine solution shall be disposed of in a manner that will in no detrimental way affect fish, plant or animal life.
- D. After the water mains have been flushed with potable water to the satisfaction of the Engineer and/or Water District, samples of water from the mains shall be taken for bacteriological analysis.
- E. The number of samples and their collection point shall be reviewed with and be acceptable to the Superintendent of Water District. The testing laboratory that will do the bacteriological analysis shall be the responsibility of this contractor. The water samples shall test bacteriologically safe before the water mains are placed in service. Certification of testing is required.

2.09 SPRINKLER DRAINS AND TEST CONNECTION

- A. Provide all necessary drain valves, drain risers, capped nozzles, auxiliary piping, etc., as required to drain the system risers and mains and all trapped portions of the system. Drain valves which are not connected to drain pipes leading to floor drains shall be hose type. Provide inspectors test connections at end of system in accordance with NFPA #13.
- B. Note: Sprinkler contractor shall furnish and install all switches. Electrical contractor shall split system zone wire and tie to existing fire alarm system.

2.10 TESTS

- A. Subject sprinkler system to tests required by and in presence of representatives of agencies having jurisdiction.
- B. Provide instruments, equipment; pay expense incurred in making tests; obtain approvals, certificate.
- C. Where evidence of stoppage appears in piping or equipment, disconnect, clean, repair, reconnect obstructed parts; also bear cost of cutting, patching adjoining work necessitated by such cleaning, repairing.

PART 3 - EXECUTION

3.01 INTERIOR PIPING

- A. Run slightly off level to low points, provide drain valve.
- B. All water piping shall maintain electrical continuity with wedges and or straps.

END OF SECTION 22 0300

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

- A. All valves other than design equipment.
- B. Operating and Maintenance Instruction Manual and Parts List.

PART 2 - PRODUCTS

2.01 VALVES

- A. General: Valves shall have following requirements:
 - 1. Working pressure stamped or cast on bodies.
 - 2. Ball valves, stem packing, serviceable without removing valve from line.
 - 3. All valves must comply with ANSI 372 for lead free plumbing products.
- B. Make
 - 1. Gate, globe and check valves: Walworth, Stockham, Milwaukee, Nibco.
 - 2. Butterfly Valves: Nibco, Milwaukee, Stockham, Watts.
 - 3. Ball valves: Nibco, Apollo, Milwaukee, Jomar.
 - 4. Balancing valves: Calibrated manual balance valves with memory stop.
 - 5. For convenience in designating type, design, etc., certain numbers are given hereinafter as "Design Equipment."
- C. Valve Types:
 - 1. Ball Valves:
 - a) 2" and Smaller: Bronze body 2-piece full port with chrome plated bronze ball. TFE seats and seals, 600 psi WP, W.O.G. screwed ends; Nibco Model #T-685-80-LF, conforms to MSS SP-110, ANSI 372.

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide valves of type called for and where shown and/or specified, and where required to service equipment whether or not shown.
- B. Provide at all major building or systems sections whether or not shown.
- C. Install all valves with stems at or above horizontal positions and all swing check valves in horizontal position only.

- D. Ball valves may be used in place of gate valves for water service through 2" size at contractor's option, unless otherwise noted.
- E. Provide new valves (size to match existing) for any existing non-operational valves which are required to allow for new installations to be made.

3.02 PLUMBING SYSTEM

- A. Install valves on all branch lines leaving mains and serving two fixtures or more; to isolate each piece of equipment or fixture, for future connections and where indicated.
- B. Use balancing valves on domestic water re-circulation lines.

END OF SECTION 220523

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 IDENTIFICATION

- A. Pipe Identification Markers: Furnish and install pipe identification markers on all piping installed under this contract, to consist of self-adhesive labels of black letters imprinted on color coded background indicating pipe fill and direction of flow. Lettering shall be 2" high on pipes 3" in diameter and over and 3/4" high on pipes under 3". Markers shall be applied to pipe, or to insulation in case of insulated pipes, on 15' centers, at branch take-offs and at each valve, whichever is closer.

- B. Refer to schedule below for piping system, background color and lettering color.

- C. Pipe Identification Schedule

	<u>System I.D.</u>	<u>Background</u>	<u>Lettering</u>
1.	Domestic Cold Water	Green	White
2.	Domestic Hot Water	Yellow	Black
3.	Domestic Hot Water Recirculation	Yellow	Black
4.	Sanitary Sewer	Green	White
5.	Sanitary Sewer Vent	Green	White
6.	Condensate Drainage	Yellow	Black
7.	Fire Protection Water	Red	White
8.	Fire Sprinkler Water	Red	White

- D. Equipment Nameplates and Valve Tags: Identify each valve, control entity or piece of equipment with stamped brass or engraved plastic nameplate permanently attached by riveting, wiring, etc. Set up complete identification system in accordance with Owner's Physical Plant Department. Each drain plug or valve shall be tagged "DRAIN". Embossed and/or pressure sensitive plastic tape labels shall not be acceptable. Furnish engraved 2" x 1" black rigid laminated plastic nameplate for each motor starter to EC for mounting. Furnish framed valve chart indicating valve number, location and usage for all valves installed under this contractor.

END OF SECTION 220553

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

- A. Manufacturer data for all materials used in Contract.
- B. Submit schedule of insulation applications.
- C. Samples, only when requested.

1.03 QUALIFICATIONS

- A. Installation of thermal insulation shall be made by competent mechanics regularly employed by and under the direct supervision of a qualified, approved insulation subcontractor.
- B. All materials shall be installed per manufacturer's written recommendations and specifications.
- C. All insulation, jackets, adhesives, and coatings, unless specifically modified, shall comply with the following:
- D. Any treatment of jackets or facings for flame and smoke safety must be permanent. Water soluble treatments prohibited.
- E. Insulation, including finishes and adhesives on the exterior surfaces of ducts, pipes, and equipment, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less as determined by an independent testing laboratory in accordance with American Society for Testing and Materials Standard E 84, NFPA 255 and UL 723. Also, same shall comply with NFPA 90A, when installed in air plenums.
- F. Work shall not commence until building is enclosed and roofs are watertight. Obtain approval from Architects before commencing work.

PART 2 - PRODUCTS

2.01 PIPE INSULATION (RIGID TYPE)

- A. Pre-formed rigid sectional pipe covering, with factory applied jacket. Material, jacket type and thickness as specified hereinafter.
- B. Insulation Material: Fiberglass.
- C. Conductivity: Maximum thermal conductivity (k), on a flat surface, shall be 0.25 Btu/sq. ft. hr. °F/inch mean temperature.
- D. Jackets: White Kraft outer surface bonded to aluminum foil and reinforced with fiberglass yarn permanently treated for fire and smoke safety and to prevent corrosion of the foil.

2.02 ACCEPTABLE MANUFACTURERS

- A. Fiberglass: Johns-Manville, CGS, (Certainteed), Owens-Corning, Knauf.
- B. Adhesives: Benjamin Foster or equivalent. Benjamin Foster (BF) numbers are used, unless otherwise noted, for convenience in designating quality of adhesive.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. "Concealed" is generally intended to mean Work within or behind various construction elements, either fixed or removable, or in crawl spaces or trenches, which are not exposed to view when project is complete.
- B. "Exposed" is generally intended to mean anything exposed to view when project is complete; as opposed to "concealed."
- C. Provide Thermal Insulation:
 - 1. Insulation is required on all piping unless otherwise indicated on Contract Documents.
 - 2. Only on clean, dry surfaces and after piping ductwork and equipment have been tested and found to be tight.
 - 3. On cold surfaces with continuous unbroken vapor seal.
 - 4. All exposed surfaces shall be white.
 - 5. Pipes individually insulated.
 - 6. Domestic cold water, hot water and hot water return piping-hanger installed around piping insulation. Provide insulation shields.
 - 7. On Sanitary drains for fixtures accessible to the disabled.
 - 8. On all roof drain bodies and storm water piping.
- D. Miscellaneous:
 - 1. Install insulation on exposed hot and cold plumbing piping to within 18" of fixture or equipment connection.
 - 2. Insulate hot and cold piping longer than 18" located inside sink cabinets, under counters, under tables, etc.

3.02 PIPE INSULATION (RIGID TYPE)

- A. Apply insulation on all systems piping including fittings, flanges, unions, strainers, and other miscellaneous attachments installed in piping system, whether exposed or concealed, except where omitted or specified to contrary.
- B. Any piping in exterior walls, spaces, overhangs, attics, or where subject to freezing: Insulate pipe with double the thickness specified. Where in wall chases: In addition to the above, pack chase with loose glass fiber insulation.
- C. Hanger Shields: Required on all piping.

D. Joints in Section Pipe Covering Made as follows:

1. Standard: Longitudinal laps and butt joint sealing strips cemented with BF 85-20 or Armstrong 520. May be stapled with outward clinching staples where concealed or recovered. Factory applied pressure sensitive adhesive lap seal may be used at contractor's option. Adhesive shall be in two strips -- one, applied to the longitudinal jacket and the other on the opposing jacket surface.
2. Vapor barrier: Provide for all cold services. Longitudinal laps and 4" vapor barrier strip at butt joints shall be sealed with white BF 85-20 or Armstrong 520. Seal ends of pipe insulation at valves, flanges, and fittings and at butt joint approximately every 21' with white BF 85-20.

E. Fittings, Valves and Flanges:

1. Concealed & Exposed: Premolded fitting covers of the same material and thickness as the adjacent pipe insulation and finished with glass cloth applied and coated with BF 30-36 "Seal-Fas".
2. Optional: In lieu of the standard method above, the Contractor has the option of using "Zeston" methods, or Ceel-Tite System provided:
 - a) Appearance and workmanship are acceptable to the Architects.
 - b) Insulation values at least as great as specified must be maintained.
 - c) Application details and manufacturer specifications shall be followed and are hereby made a part of the Contract Documents.

3.03 PIPE INSULATION MATERIALS

A. Schedule of Piping Insulation:

Schedule of Piping Insulation

Service	Material	Insulation Thickness
Domestic Cold-Water	Glass Fiber	All Sizes – 1"
Domestic Hot Water	Glass Fiber	105-140 deg. F = 1" 141-180 deg. F = 1.5"
Domestic Hot Water Recirculation	Glass Fiber	105-140 deg. F = 1" 141-180 deg. F = 1.5"
Roof Drains, Storm and Drainage Piping	Glass Fiber	All Sizes – 1/2"
Condensate Drainage Piping	Glass Fiber	All Sizes – 1/2"

- B. Note: Jacket material, finish, fitting covers, etc. (for all piping) shall be as specified for "exposed" and/or "concealed" application. Color shall always be white unless specifically approved otherwise.
- C. Insulation Covers for Piping and Pipe Fittings: Provide PVC (Zeston) type insulation covers for all exposed insulated pipe and pipe fittings, other than Mechanical Rooms. Cover shall be fastened with a vandal resistant system and as specified.
- D. Cover system shall be installed from floor to ceilings, complete. In areas where a ceiling is not present cover system shall be provided from the floor to 10' 0" above finished floor.

END OF SECTION 22 0715

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

- A. All items specified in this section under Part 2 - Products.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All pipe and fittings new and marked with manufacturer's name; comply with applicable ASTM and ANSI Standards.
- B. All water piping fittings must comply with ANSI 372 for lead free plumbing products.

2.02 COPPER PIPE AND FITTINGS

- A. Pipe: Hard temper, ASTM B-88; Type K, L, M, or DWV, as called for. Soft temper only in specific cases. Plans show copper tube sizes.
- B. Tees, Elbows, Reducers: Wrought copper or cast bronze; solder end connections; ASTM B-62, ANSI B16.22. mechanical fittings ASTM B-88
- C. Unions and Flanges: 2" and smaller use unions, solder type, cast bronze, ground joint, 150# swp; 2-1/2" and over use flanges, cast bronze, companion type, ASME drilled, solder connection, 150 swp. Bolts shall be same as for steel pipe.
- D. Press Fittings: Bronze or copper shall conform to the material requirements of ASME B16.18 or ASME B16.22, and the performance requirements of IAPMO PS117, and ICC LC1002. Press fittings 1/2-inch thru 4-inch for use with ASTM B88 copper tube type K, L, or M and 1/2-inch up to include 1-1/4-inch annealed copper tube. Press fittings shall have either an EPDM, FKM, or HNBR sealing element and integral detection feature intended to identify un-pressed fittings. 2-1/2-inch thru 4-inch shall have a 420 stainless steel grip ring, PBT separator ring, EPDM or FKM sealing element and integral detection feature. Sealing elements shall be factory installed and shall be verified for the intended use.
 - 1. Note: Only Press fittings with EPDM sealing element that conform to NSF 61-pw shall be installed in a potable water system.
 - 2. Acceptable Manufacturers: Veiga ProPress, ApolloPRESS or Nibco.

2.03 SOIL PIPE AND FITTINGS

- A. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.
- B. Pipe: ASTM A-74 service weight cast iron, coated.

- C. Fittings: Service weight type with neoprene gasket of same manufacturer as piping, acceptable for piping buried only in earth.
- D. No-Hub (Above Grade Only):
 - 1. Pipe: ASTM C-564 no-hub cast iron, coated.
 - 2. Fittings: Cast iron no-hub pattern with heavy-duty rubber gasket and stainless steel clamp assembly. Mission Rubber or equal. ASTM # 1540, ASTM C564.

2.04 DIELECTRIC PIPE FITTINGS

- A. Tensile strength, Federal Specification WW-U-531A, union or flange design, 250 psi pressure rating, threaded or solder joint, constructed to prevent gasket from squeezing into internal opening.
- B. Make: Epco or equivalent.

2.05 HANGERS, INSERTS AND SUPPORTS

- A. Hangers, Inserts, Clamps, Etc.: Carpenter & Patterson, Central Iron, Elcen, Fee & Mason, Grabler and Grinnell.
- B. Hangers: Adjustable, steel clevis type, cadmium plated or galvanized except where in contact with copper piping. Copper plated or PVC coated where in contact with copper piping.
- C. Hanger Shields: Required on all piping.

- D. Spacing Schedule:

Pipe Size	Steel (ft)	Copper (ft)	No-Hub Cast Iron *	Rod Size
3/4" to 1"	12	6	Each	3/8"
1-1/4" to 1-1/2"	12	6	Horizontal	3/8"
2" to 4"	12	10	Joint	1/2"

*Cast iron "No-Hub" to be supported on all sides of fittings & Joints

- E. Piping systems with material not listed in above schedule shall be supported and protected in accordance with manufacturer's recommendations and as approved.
- F. Inserts: Equal to Grinnell Fig. #281, maximum loading 1000 lbs., galvanized finish, and Fig. #285, maximum loading 400 lbs. Use approved beam clamps if possible.
- G. Supports:
 - 1. For Weights Under 1000 lbs.: Support all Contract Work with approved type "Drill-In" inserts equal to "red Head," "unistrut," beam clamps or other structurally approved support. The factor of safety shall be at least four (4). Follow manufacturer's recommendations.
 - 2. For Metal Decks: Drill hole through for hanger rods and imbed a bolted plate in concrete or use Phillips "Red Head" devices designed for this application. All cases must have safety factor of four (4).

2.06 PIPING ACCESSORIES

- A. Escutcheon Plates: Steel or cast iron polished chrome, split hinge type with setscrew, when used at ceiling and floor locations. Special high plates where required for extended sleeves. Chrome plated in vicinity of all fixtures. Provide escutcheons at all pipe penetrations thru ceilings, floors and walls exposed to view.

2.07 SLEEVES

- A. Standard Type: Schedule 40 black steel pipe sleeves, two pipe sizes larger than the pipe, required for all structural surfaces.
- B. Sheet metal sleeves permitted only for nonstructural surfaces and existing construction. Sheet metal sleeves shall be 18 gauge minimum and shall be properly braced to prevent collapsing.

2.08 SEALING ELEMENTS

- A. Waterproof Type: Synthetic rubber material with zinc plated bolts equal to "Link-Seal" Series 200, 300 or 400.

2.09 PIPING MATERIALS (PLUMBING)

- A. Water Distribution Piping:
 - 1. Copper tubing Type "L" ASTM B75, ASTM B88, ASTM B251, ASTM B 447. Lead-free soldered joints or mechanical joints.
- B. Above Grade Drainage & Vent Piping:
 - 1. Cast-iron soil piping with no-hub connections ASTM A74, ASTM A888.

PART 3 - EXECUTION

3.01 EQUIPMENT AND SYSTEMS

- A. All equipment and systems as shown on the drawings or specified herein shall be installed in accordance with the provisions of each applicable section of these Specifications and all local and state codes and regulations having jurisdiction.
- B. All work shall be installed in a workmanlike manner as determined by Architects.
- C. Accurately establish grade and elevation of all piping before setting sleeves. Install piping without springing or forcing (except where specifically called for), making proper allowance for expansion and anchoring. Arrange piping at equipment with necessary offsets, unions, flanges, valves, to allow for easy part removal and maintenance, as approved.
- D. Offset piping and change elevation as required to coordinate with all other trades.
- E. Avoid contact with any part of other mechanical or electrical systems.
- F. Provide adequate means of draining and venting all units, risers, circuits and systems.
- G. Conceal all piping unless otherwise specified.

- H. Install piping and connections approximately as indicated or directed, straight, plumb, direct, parallel and close to building walls, partitions, ceiling, in general, with groups of pipes parallel to each other and close to structural members allowing for insulation and access for servicing valves, etc. Horizontal piping to be installed as high as possible without sags.
- I. Coordination with other trades: Check Contract Drawings with all others, anticipate and avoid interference with other installations. Obtain decision or approval from Architect for proposed group installation and before proceeding, and for clearances in structure and finish.
- J. Fixture branches exposed only as required for final connections.
- K. Over Electrical Equipment: Prohibited. Special cases may be permitted with approval of Architect, protecting copper drip pan.
- L. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction. Install piping parallel with lines of building, properly spaced to provide clearance for insulation. Make all changes in direction and branch connections with approved fittings. All cleanout plugs, bushings and nipples, required for gauge and instrument installation shall be brass. Do not install valves, unions and flanges in inaccessible locations.
- M. Materials used within a system and between systems shall be consistent. If this is not possible, install approved dielectric fittings.

3.02 HANGERS, INSERTS AND SUPPORTS

- A. No piping shall be supported by wires, band iron, chains, or from other piping, nor by vertical expansion bolts. Support piping with individual hangers from concrete inserts, approved welded supports, or beam clamps of proper configuration and loading design requirements for each location; replace if not suitable. Follow manufacturer's safe loading recommendations. Always obtain approval.
- B. Suspend with rods of sufficient length for swing and of size as previously scheduled, using four (4) nuts per rod. Use rods and nuts having electroplated zinc or cadmium (0.005" minimum) finish.
- C. Provide additional approved structural steel members, having one coat rustproof paint, where required for proper support.
- D. Provide oversized hangers where insulation/supports must pass between pipe and hanger.
- E. Hangers, when attached to joists, shall only be placed at the top or bottom chord panel point. Only concentric type hangers are permissible; "C" type not permitted.
- F. Riser Clamps: Provide riser clamps for each riser at each floor. Allow for escutcheon plates.

3.03 PIPE CONNECTIONS

- A. Solder Connections: Use only 95/5 nonacid flux and clean off excess flux. Also remove excess solder from piping.
- B. Threaded Connections: For steel pipe and brass pipe. Clean out tapering threads, made up with pipe dope; screwed until tight connection. Pipe dope must be approved for application.
- C. Dielectric Pipe Fittings: Protect fittings from excessive heat.

3.04 SLEEVES

- A. All underground pipes and conduits, regardless of their contents, shall be provided with sleeves at the foundation wall and shall be sealed at the section of entry into the building with a material that will form a gas-proof barrier.
- B. Provide for all pipes passing through floors, walls or ceilings.
- C. Extend 1/8" above floor in all finished areas except those with floor drains or in Penthouse; use steel pipe sleeves 2" above floor in excepted areas. Use steel pipe sleeves in all bearing walls, structural slabs, beams and all other structural surfaces, and where specifically called for.
- D. Sleeves, where installed in walls of shafts, shall be as small as practical, consistent with insulation, etc., so as to preserve fire rating of shaft walls.
- E. Fill abandoned sleeves with concrete.
- F. Where floors are membrane waterproofed, use flashing clamp device on sleeves equivalent to Josam Series 1880 "Riser Sleeve".

3.05 ESCUTCHEON PLATES

- A. Provide polished chrome escutcheon plates for all exposed piping passing through floors, walls or ceilings, in all rooms except Mechanical Rooms.
- B. Cut plates if necessary to fit conditions.

3.06 SLEEVE PACKING

- A. Tightly seal void space at all sleeves throughout building as follows:
 - 1. Interior locations: Firmly pack with fiberglass, the space between sleeve and pipe, then neatly caulk with caulking gun and approved material.
 - 2. Exterior walls above grade: Use sealing element.
 - 3. Exterior walls below grade: Use sealing element.
 - 4. Cored holes: Method shall be approved or use sealing element.
 - 5. Fire rated, partitions and floor slabs: Use fire rated sealing elements, materials and methods.
 - 6. Waterproofed floors without membrane: Use Architects' approved sealing element, device or compound.
 - 7. Waterproofed floors with membrane: Use Architects' approved sealing element, device or compound.

3.07 TESTS

- A. Refer to Section 220010 for testing of plumbing systems.

3.08 PIPE LINE SIZING

- A. Pipe sizes indicated on Contract Documents are to be maintained. Pipe size changes made only as approved by Engineer, or required by State or local codes.
- B. Where discrepancy in size occurs, the larger size shall prevail, unless otherwise directed by the Architects.

END OF SECTION 221116

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

- A. All items specified under Part 2 - Products of this Section, including pipe and fittings.

PART 2 - PRODUCTS

2.01 WATER PIPING

- A. Refer to Section 221116 - Piping Systems and Accessories; for acceptable materials.

2.02 DISINFECTION

- A. The Contractor shall disinfect the entire hot and cold water system. This shall include all hot water circulation piping and connecting supply mains. Renovations to existing piping systems shall be isolated with new valves by Contractor for testing of new system only.
- B. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below.
- C. A chlorine solution shall be injected into and circulated through the entire hot and cold water system. Operate all hot and cold water faucets, flush valves, mixing valves and metering valves. Duct tape all metering valves to hold in on position. Continue flow of water from system until a determined uniform chlorine count of 50 ppm is reached. Then shut off all flow and let systems stand full.
- D. Tube test samples of hot and cold water in each fixture area every 8 hours to determine chlorine residual content.
- E. If the chlorine residual content drop is more than 10% in any 24 hour period, system must be injected with additional chlorine and Step A repeated. This shall continue until a 95% chlorine residual level remains over 24 hours.
- F. After the system test has been accepted by the Architect or Engineer, the entire system shall be drained and refilled. It is important that if the building has a septic system all water must be drained on to paved areas of parking lots. The Contractor shall install all necessary valves at low points and furnish any pumps and drain piping to accomplish this.
- G. Prior to final test, the system should be flushed through plumbing fixtures until any concentrated chlorine odor is undetectable.
- H. A final test of both hot and cold water shall be taken at the furthest point of the system by a certified testing agency. Full bacteria and metals test shall be performed to verify the water meets all potable drinking water standards.

PART 3 - EXECUTION

3.01 PIPING

- A. Run slightly off level to low points; provide drain valves.
- B. Provide shock arrestors where shown, or specified.
- C. Branch headers serving flush valves; full size as shown.
- D. Provide dielectric pipe fittings when connecting to piping system of dissimilar metals.
- E. Supply piping to all fixtures, faucets and flush valves shall be anchored to prevent movement.
- F. Provide and install necessary wood or metal backing material to secure piping, flush valves, faucets, etc.
- G. Piping shall be run to avoid all electrical panels and equipment.

END OF SECTION 22 1127

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

- A. All items specified in this Section under Part 2 - Products.

PART 2 - PRODUCTS

2.01 FLOOR DRAINS AND FLOOR SINKS

- A. Acceptable Manufacturers: Jay R. Smith, Josam, Zurn or Wade.
- B. FD-1: Zurn #ZN-415 floor drain, dura coated cast iron body with bottom outlet. Combination membrane clamp and adjustable collar. 5" polished brass nickel bronze round top. Provide with Rector-Seal Sure-Seal Trap Guard
- C. FS-1: Zurn #Z-1910-P-25 Sani-Flor receptor 8"x8"x6" deep cast iron body and square slotted medium duty grate, with white acid resisting porcelain enamel interior and top complete with white acid resisting enamel bucket.

2.02 CLEANOUTS

- A. Acceptable Manufacturers: Jay R. Smith, Josam, Zurn or Wade.
- B. FCO-1: Zurn #ZN-1400 level-trol adjustable floor cleanout D.C.C.I. body with polished nickel bronze scoriated top, gas and water tight. ABS tapered thread plug and scoriated round top adjustable to finished floor
- C. WCO: Zurn #Z-1446 cleanout with round stainless-steel wall access cover.
- D. BCO: Zurn #1445 cleanout tee.

PART 3 - EXECUTION

3.01 CLEANOUTS

- A. Install cleanouts out of traffic patterns; provide offset from unnecessary stress on basin at these points.
- B. Do not locate under doors or under equipment, or behind cabinets.

END OF SECTION 22 1130

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.02 ALLOWANCES, ALTERNATES AND UNIT PRICES

- A. Refer to Division 1 specifications for allowances, alternates and unit prices required as part of this Contract.

1.03 INTENT

- A. The intent of the drawings and these specifications is to provide all systems complete and operative. Whether indicated on the drawings and/or included in the specification or not, provide all materials, equipment and labor usually furnished with such systems.

1.04 DEFINITIONS

- A. Provide: Furnish, install and connect.
- B. Furnish: Supply material only.
- C. EXR: Existing to remain.
- D. MC: Mechanical Contractor-note MC and HC (Heating Contractor) shall be interchangeable for all drawings and specifications.

1.05 SCOPE OF WORK

- A. This Contractor shall do all work, furnish all labor, tools and equipment necessary for all the MECHANICAL work all as indicated on the drawings and specified herein.
 - 1. Removal of existing equipment as indicated on drawings.
 - 2. All cutting and patching.
 - 3. Heating boiler, complete with accessories and controls.
 - 4. Replacement burner packages, associated controls, fuel piping as required for each boiler and new hot water heater.
 - 5. Roof top units, complete with curbs, etc. Flashing by G.C.
 - 6. Variable refrigerant system, complete with all accessories.
 - 7. Boiler breeching, supports and accessories
 - 8. Underground heating fuel storage tank, fuel piping, vent piping, valves, and all accessories.
 - 9. Converter and steam specialties.
 - 10. Central station air handling units.
 - 11. Air cooled condenser units;
 - 12. Unit ventilators.
 - 13. Chillers, complete with piping and accessories.
 - 14. Cooling towers, complete with piping and accessories.
 - 15. Fan coil units.
 - 16. Ductless split air conditioning units, complete with piping, controls, supports and accessories.
 - 17. Cabinet unit heaters, complete with piping, controls, supports and accessories.
 - 18. Convectors, complete with piping and accessories.

19. Fin tube radiation, complete with piping and accessories.
20. Electric fin radiation, complete with accessories.
21. Unit heaters, complete with piping, supports and accessories.
22. Duct coils, complete with piping and installation accessories.
23. Circulating pumps complete with motors, controls, supports and accessories.
24. Exhaust fans, complete with accessories, curbs, etc., flashing by GC.
25. Humidifiers, complete with piping and accessories and supports.
26. Drain water condensate pump, complete with piping, tank, accessories and support.
27. Pipe fittings, hangers, supports, valves, and piping specialties as required to make complete heating system.
28. Refrigeration piping, fittings, valves, etc.
29. All diffusers, registers and grilles complete with accessories.
30. All louvers provided by Contractor.
31. Sound traps.
32. Galvanized ductwork (or specialty ductwork where noted) to serve supply, relief and exhaust systems complete with control devices and accessories, unless otherwise noted.
33. Welding hood, including exhaust fan, complete with motors and accessories.
34. Insulation both thermal and acoustical to serve piping, breeching, ductwork systems, equipment, housings and accessories.
35. Temperature control system complete to serve all MECHANICAL equipment and systems complete with accessories.
36. Testing and balancing of all heating, ventilating and air conditioning installations to include sheetmetal ductwork, air conditioning supply and exhaust systems, heating and cooling systems and temperature control system. Balancing shall include NC ratings as described herein.
37. Special testing and balancing requirements for existing MECHANICAL equipment to include repair of existing equipment as required to obtain air flow as indicated on drawings.
38. Servicing of heating, ventilating and air conditioning facilities are required for guarantee period. Provide competent factory trained men at site for purpose of instructing Owner's personnel in proper operation and maintenance of all new MECHANICAL facilities.
39. Concrete pads, 4" high unless otherwise noted on drawings, to provide housekeeping elevation for boilers, pumps and such other equipment as shown on drawings that require a pad. Coordinate installation of pads with GC to insure secure bonding of pads to floor structure. This contractor shall be responsible for installation of pads.
40. Temporary heat as required by Architect's Special Conditions.

1.06 TEMPORARY SERVICES

- A. Temporary Heat: In accordance with Architect's specifications and/or conditions, contractor shall have the permanent heating system capable of providing heat to the new work areas when required. The term heating system shall include all work or components necessary to operate heating system. For temporary usage, it is not required that this work be in a finished condition, i.e., covers in place, etc. Cost of fuel consumed for temporary heat from permanent systems only shall be paid by owner.
- B. The use of permanent system will be allowed only if the building is fully enclosed with no construction dust to clog heating/cooling coils, heat recovery components, fans, etc.
- C. At the completion of work, Contractor shall turn over to the Owner all equipment used for temporary heat in a new, as purchased condition. Contractor shall replace filters with new ones, clean all components which shall include: unit casings, ductwork, grilles, diffusers, etc., re-lubricate all moving parts, replace belts if required and perform any other work necessary (as determined by Architect and Engineer) to put equipment in a "new" condition.

- D. Contractor shall take all measures necessary to insure that dust, dirt, or debris does not enter air systems while in operation for temporary heat and shall change filters as often as necessary. Under no circumstances shall air handlers be allowed to operate with no filter in place. All duct in the work area shall be sealed so no dust or debris will enter duct.

1.07 CONTINUITY OF UTILITY SERVICES

- A. It is of paramount importance that each utility service operate continuously and without interruption. Whenever this contractor plans to make changes or alterations to any existing utility service, such plans shall result in no or minimum service interruption or inconvenience to Owner. This contractor shall plan and schedule any change or alteration to an existing utility service with Architect and Owner. Such planning, timing, and/or scheduling shall be approved by both these parties.

1.08 CODES AND STANDARDS

- A. All materials, equipment, and installations by this contract shall be in accordance with the latest editions of the following applicable requirements:
1. 2020 New York State Building Code, including all applicable amendments supplements to the following:
 - a) 2020 International Building Code
 - b) 2020 International Existing Building Code
 - c) 2020 International Fire Code
 - d) 2020 International Plumbing Code
 - e) 2020 International Mechanical Code
 - f) 2020 International Fuel Gas Code
 2. 2020 Supplement to the New York State Energy Conservation Construction Code, including all applicable amendments to the following:
 - a) 2020 International Energy Conservation Code
 - b) 2013 ASHRAE 90.1
 3. 2020 Uniform Code Supplement (May 12, 2020)
 4. New York State Department of Environmental Conservation.
 5. Conform to requirements of NEMA.
 6. Bear label of Underwriters Laboratories, Inc.
 7. National Electrical Code NFPA Article 70, latest edition.
 8. New York State Health Code.
 9. Local Utility Standards.
 10. Local Municipal and/or city standards.
 11. Industrial Code Rule #4 and #14 (12NYCRR 4 and 14) (Standards for boiler installation).
 12. AMBA Boiler Rating.

13. ASME Boiler Pressure Vessel Code.
14. ASHRAE Standard 15.
15. Conform with applicable requirements of ASTM - Regulations and Standards for Pipe and Pipe Fittings.
16. Be in accordance with USAS - Code for Pressure Piping, latest edition.
17. For external and internal duct insulations, have flame spread rating of 25 or less and smoke developed rating of 50 or less when tested in accordance with ASTM Standard E84.
18. Sheetmetal and Air Conditioning Contractor's National Association, Inc. (SMACNA), latest editions.
19. Conform with applicable requirements of Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A, and Code for Safety to Life from Fire in Buildings and Structures, NFPA 101.
20. Conform to requirements of ASHRAE 90.1, latest edition.
21. Be in accordance with design standards outlined in ASHRAE Handbooks, latest edition.
22. Conform to requirements of Owner's insurance carriers.

1.09 SUBMITTALS & SUBMISSION REQUIREMENTS

- A. All submittals shall be in accordance with Division 1 requirements, the following requirements listed below, and also as indicated in each specification section. All submittals not complying with the listing above will be returned to the contractor without being reviewed. Rejection by Architect or Engineer of any items submitted shall require resubmittal of acceptable items.
 1. Within (20) days after receiving notice to proceed, submit to Architect for review complete descriptive dimensional data and ratings for equipment and materials proposed to be furnished and installed.
 2. All materials submitted shall clearly state the job name and specification section(s) that it applies to.
 3. Any package containing more than one piece of equipment or material shall also contain a schedule clearly listing all items in submittal. Schedule page (s) shall also indicate project name and building name.
 4. All submittals must be clearly marked using nomenclature used in this specification for proper item identification, schedule of usages, model numbers, construction materials, performance, data, etc.
 5. Projects involving multiple buildings must have the submittals separated by building. Submittals in which buildings are combined will not be accepted. (Exception: When specifically approved by engineer, basic materials may be submitted once.)

6. The contractor shall insure that dimensions of equipment to be used conform to the space allocated for the equipment on the drawings.
 7. Submittals traced or copied from contract drawings are not acceptable and will be returned without review.
 8. In the event material and/or equipment is installed prior to obtaining approval of shop drawings, and in the sole opinion of the Owner's Agent, this material and/or equipment does not meet the specifications, the Contractor shall be liable for the removal and the replacement at no additional cost to the contract.
- B. Samples: When requested by Engineer, provide samples of both specified equipment and proposed substitutions for review by the Owner's Agent. Such equipment shall be delivered to a location designated, or erected at the job site as directed. When neither is physically possible, arrange for the Owner's Agent to visit an acceptable site where the proposed equipment can be inspected.
- C. Substitutions (where allowed within the project):
1. After bid award if there are any units/piping/equipment the contractor would seek to substitute on, they must indicate in writing the specific equipment.
 2. All substitutions shall be clearly highlighted, and in bold print, on the front cover of any submittal that it is a substitution.
 3. Substitutions received after 45 days will not be considered.
 4. Supporting documentation shall be provided describing why the item is an equal and listing the major difference.
 5. Submittals for equipment or materials other than as specified shall be accepted for review by the Owner's agent.
 6. Any substitution should be sent in as an RFI and reviewed prior to bid for acceptance. If the unit is submitted after the bid date, the submittal may be rejected without review.
 7. Approval of substitute equipment shall be based on performance, dimensional, functional, physical and aesthetic compatibility to the equipment specified as determined by the Owner's agent and approved by the engineer. Any substitution shall meet any scheduled performance and characteristics noted within its particular specification section.
 8. Where substitute equipment is approved, the contractor shall be responsible for, and bear the cost of any necessary changes by his trade or other trades to make the system complete and operable, including but not limited to any design fees and structural or steel changes required to implement a substituted unit.
 9. Contractor is fully responsible for providing coordination between all trades affected by equipment substitution.
 10. When requested, contractor shall submit layout drawings indicating new dimensions and arrangements of substituted equipment. Layout drawings shall indicate all revisions necessary for all services affected by substitution.

1.10 SUBSTANTIAL COMPLETION REQUEST FOR PUNCH LIST

- A. Contractor shall submit a letter in email form stating that the work is substantially complete and ready for Punch List review by Engineer.
- B. Contractor shall note which areas are substantially complete by Building (if multiple buildings) and by Area according to the Key Plan.
- C. Contractor shall list all items that are known to be incomplete at time of submission.
- D. If the request is for a partial Punch List, Contractor shall also include a list of room numbers/room tags.
- E. When letter is received by the Engineer, site review(s) will be coordinated with the Construction Manager, Clerk, Architect.

1.11 CUTTING AND PATCHING

- A. This contractor shall bear the cost of all cutting and patching required by and for the installation of this work. This contractor shall perform all cutting and patching unless otherwise indicated on drawings or if directed by the Architect.
- B. Patching of fire rated floors, walls, partitions, etc. shall be made using new materials equal to the fire rating of the existing.
- C. Should changes, omissions or errors in this contractor's work require cutting, patching or making alterations in any portion of new construction, such work will be performed by GC at contractor's expense.
- D. Cutting and patching of roof surfaces and structures shall only be performed by a qualified contractor, as approved by the Architect. The work of this contract shall bear the cost of above mentioned cutting and patching. This contractor shall insure that existing roof warranties remain in force.
- E. This contractor shall furnish lintels, sized to accommodate structure above opening, where cutting and patching is to be performed on load bearing walls. Contractor shall obtain written approval for all lintels prior to installation.
- F. Cutting shall be done in a manner which will not adversely affect the strength of the building. Holes and openings shall be neatly cut so as to provide a finished appearance and shall be patched around the edge where required for a finished appearance. Provide temporary bracing, shoring, etc. as required.
- G. Patching shall be structurally sound and match the existing materials and finish of adjacent materials. Patching is required in finished areas, wherever existing work is removed, at the sides of openings, etc.
- H. At the completion of the work, all evidence of alteration will be as inconspicuous as possible.
- I. If the MC has a duct or pipe going through a wall where the GC made an opening for the MC, the MC shall be responsible to infill the space between the duct/pipe and wall. Also refer to section 1.22 Penetrations through fire rated construction.

1.12 FIELD INSPECTION

- A. As there are various conditions at the site which do not show on the accompanying drawings, or which are at variance with the conditions indicated on the drawings, it is important that each bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.
- B. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.13 INSTRUCTION SERVICES AND MANUALS

- A. Instructions:
 - 1. Provide competent personnel to remain at the jobsite for necessary time to instruct the Owner's personnel in proper operation and maintenance of installation made by this contractor.
 - 2. This contractor shall be responsible for notifying and instructing Owner's personnel on all equipment operations, maintenance requirements, etc. Furnish operating training session(s) for equipment listed.
 - 3. The Owner shall be responsible for establishing an operating and maintenance program for all equipment listed.
- B. Training Session: A training session shall be held for each system and/or item listed below: (Note: For Temperature Controls refer to Temperature Control Sections for training requirements.)

Item	Description	Training Hours For Each Bldg
1.		
2.		
3.		

- C. The instruction shall include the following types of information:
 - 1. System overview
 - 2. Major component designation
 - 3. System operation procedures
 - 4. Maintenance scheduling and procedures
 - 5. Provide a list of spare components each system would normally require
- D. Services: Provide services required, for all equipment specified under this contract, for a period of (1) year after written acceptance by the Owner.
- E. Manuals: Submit (3) sets of Operation and Maintenance manuals. Each set shall contain the manufacturers' data, operating instruction parts catalog and maintenance procedures for each piece of equipment. Include normal maintenance servicing schedule to be performed by the Owner.
 - 1. For projects containing multiple buildings, manuals shall be submitted separately for each building.

1.14 DELEGATED DESIGN

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.
- C. At completion of work, contractor to submit written report of acceptance by service representative and/or qualified third party testing agency that systems are installed in accordance with manufacturer's details and requirements.
- D. Delegated Design Systems:
 - 1. Seismic Restraint of Mechanical Systems
 - 2. xxx

1.15 PERMITS, CERTIFICATES AND FEES

- A. This Contractor shall obtain and pay for permits, certificates, fees etc. listed below and as required. Costs for permits, fees etc. shall be included in the base bid amount.
 - 1. All required applications and permits to begin work
 - 2. Certificate of inspection including Third-Party Agency.
 - 3. All municipal connection charges
 - 4. All local utility charges (power, telephone, cable, etc.)
 - 5. Fees and charges shall be obtained directly from the respective authority having jurisdiction
 - 6. Fees and charges for hazardous waste hauling as required by DOT, DEC, etc.

1.16 REMOVAL, DISPOSAL AND HAZARDOUS MATERIALS

- A. All removed equipment shall be removed from the site and properly disposed of.
- B. All hazardous materials must be disposed of in compliance with ENCON and all other regulatory agencies. The contractor shall provide the owner with written chain of custody reports and final destination of disposal.
- C. The Owner may wish to keep certain equipment, therefore, check with Owner before removals to determine what may be salvageable.
- D. Unless otherwise noted, all equipment to be removed shall have all accessories and supports

removed with it, whether indicated or not. In addition, any refrigeration containing equipment that is shown for removal shall have all refrigerant evacuated from the system and properly disposed of and all refrigerant piping removed from the site. Refrigerant recovery shall be performed by a technician certified in the maintenance, service, repair, and disposal of refrigerant containing equipment per EPA.

- E. Any equipment, piping or ductwork that has been removed in the project and has left an opening and/or anchor points in a floor, wall or roof shall have the openings and voids infilled to match existing conditions.

1.17 GUARANTEE

- A. Contractor shall guarantee all work furnished through this contract including work performed by sub-contractors, for a period of (1) year (unless otherwise noted), from the date of final acceptance. Contractor agrees to repair or replace any defective work or materials at no additional cost to the Owner. Contractor shall also pay for any damage to other work resulting from repairs to defects. Contractor shall furnish written guarantees to the Owner's agent in accordance with the general conditions.

1.18 INSTALLATION

- A. This contractor shall coordinate scheduling and installation of work with other contractors, sub-contractors and other trades. The contractor is also required to coordinate all work with owner supplied materials, direct contracts, and normal building operations, if any.
- B. All finished work shall be neat and workmanlike. All work of a special nature shall be performed by skilled and qualified workmen who can present credentials showing experience in said trade. New systems shall be delivered to Owner complete in perfect working order, tested and balanced in full accordance with plans and specifications. Existing systems shall function in same manner as before this work was performed. Any malfunctions which arise in existing systems as a result of demolition or alteration of parts of such systems shall be corrected.
- C. Layout of equipment, accessories and piping systems in plan is generally diagrammatic unless specifically dimensioned or detailed. Check project drawings and existing site conditions before installing work for interference's as governed by structural or other conditions. Owner reserves the right to make reasonable changes in location of equipment, accessories or piping systems prior to "roughing-in" without involving additional expense. Exact dimensions shown upon plans will be subject to verification and confirmation of exact conditions at site at time of construction. "Plus or minus" dimensions are shown upon drawing as a guide only. Exact surrounding conditions are governed by final equipment selection and/or other like details.
- D. Furnish all new equipment and materials as described herein. Any material, operation, method or device mentioned, listed or noted within this specification, if not specifically mentioned as furnished or installed by others, shall be furnished and installed by this contractor.

1.19 STORAGE OF MATERIALS

- A. For all ductwork, piping and insulation brought to the jobsite, it shall be protected from all environmental elements. This shall include, but not limited to, water, dust, chemicals and other hazardous materials. It shall be stored within a protected area in the building.
- B. All ductwork onsite shall have a wrap on it to prevent the duct from having any dust, debris or other

hazardous materials from becoming adhered to the interior of the duct. No duct may be stored where it could be rained on. Also refer to section 233330, low velocity ductwork, for additional information.

- C. All insulation on the jobsite will be stored in an area that will protect it from weather damage.

1.20 START UP

- A. A start up shall be performed for all new MECHANICAL equipment (MECHANICAL equipment shall be defined here as any MECHANICAL unit that requires power or a temperature controls connection). The manufacturers representative will be onsite and unit operation will be verified, including but not limited to air flow, heating and cooling setpoints are attained and unit functions within manufacturers parameters. A written report shall be furnished to the architect.

1.21 TESTING AND INSPECTION

- A. Inspections required for any ordinances, regulations, instructions, laws, rules, standards and practices that require any work to be inspected or tested shall be performed. Contractor shall give Owner, Architect and Engineer timely notice of readiness of work for inspection or testing and the date fixed for said inspection or testing.
- B. Third-Party Agency must inspect completed installation and present Owner with Certificate of Inspection showing approval.
- C. Required local or municipal inspection processed and present Owner with certificate indicating approval of such governing bodies.
- D. Contractor shall submit a written report to Architect, copy to Engineer, on results of each inspection or test on system or equipment supplied. Report shall contain all pertinent information, recommendations, approvals, additional work required, etc.

1.22 RECORD DOCUMENTS

- A. When required by general conditions or other Division 1 Section, this Contractor shall prepare and turn over to Owner's agent record As-built documents. As-built drawings will include actual equipment location layout, service connections, ductwork and piping layouts, valve locations, etc.
- B. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

1.23 IDENTIFICATION AND NAMEPLATES

- A. Provide engraved plastic labels screwed to all MECHANICAL equipment furnished under this contract including but not limited to: pumps, air handling units, rooftop units, exhaust fans, condensing units, control panels, starters, switches, panels, etc. Labels shall have black background, white letters; minimum letter height 3/8" high, self adhesive labels or punch tape type labels are not acceptable.

1.24 PENETRATIONS THRU FIRE RATED CONSTRUCTION

- A. All penetrations by this contract through rated construction shall be sealed fire safe by a UL listed approved method.

- B. All piping penetrations through walls, floors, etc. shall be sleeved.
- C. All ductwork penetrations shall be furnished with trim frames.
- D. All piping and ductwork penetrations through fire rated partitions, walls, floors, etc. shall be installed as follows; penetration shall be oversized 1/2" to 3/4" maximum. This contractor shall pack with fireproofing insulation, type FS cerablanket. Outside of penetrations (exposed surfaces around pipes and ductwork) shall be caulked and sealed with flame stop V, as manufactured by Flame Stop, Inc.; or an approved equal. Flame stop sealant shall be troweled smooth for finishing as required.

1.25 CONFINED SPACES

- A. All work in pipe tunnels, mechanical pits, well manholes, etc. shall be performed by skilled tradesman and laborers with current certification for working in confined space. Contractor shall bear all costs to provide all safety equipment, ventilation, etc. as required by State and Federal Regulations and shall obtain all necessary permits for such work.
- B. Contractor shall submit copy of current certifications and photo I.D. of all tradesman and laborers who will be working in confined spaces on this project.

1.26 COORDINATION

- A. Layouts of duct and piping systems shown on contract drawings are diagrammatic. Actual duct and piping layouts shall be coordinated in the field by the contractor. Ductwork shop drawings shall be submitted for approval (see next section for coordination drawings if applicable). Coordinate with other trades and with existing conditions, as required for proper installation of all systems. Contractor shall verify that ductwork and piping layouts are coordinated with all other construction trades which might cause a conflict. Any changes due to systems not being properly coordinated shall be the contractor's responsibility.
- B. All offsets, elbows, duct/pipe transitions, air vents, drains and accessories required to accommodate field changes found during coordination drawings are the responsibility of the contractor at NO additional cost.
- C. NOTE: Ductwork and piping drawings will NOT be given to the contractor since it is expected of the contractor to field verify and draw the ductwork and piping.
- D. Refer to section 013100 Project management and coordination for obtaining cad files from the architect.
- E. All offsets, elbows, duct/pipe transitions, air vents, drains and accessories required to accommodate field changes found during shop drawings are the responsibility of the contractor at NO additional cost.

1.27 COORDINATION DRAWINGS

- A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings at not less than 1/4" = 1'-0" scale. These drawings shall identify and show elevations of all trades and resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas.
- B. Prepare three-dimensional component conflict analysis (building information modeling - BIM) as part of coordination drawings. Refer to section 013100 Project management and coordination for obtaining

revit models from the architect (if available). Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.

- C. Contractor shall perform the final coordination review. As each coordination drawing is completed, Contractor will meet with Architect to review and resolve conflicts on the coordination drawings.
- D. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
- E. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
- F. Indicate dimensions shown on drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- G. Additional design, drafting and/or engineering time to fully complete the coordination drawings shall not be considered an additional cost to the project and shall be part of the contract.
- H. Show the sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
- I. Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.
- J. Coordination drawings shall be required for all boiler rooms and mechanical rooms.
- K. Prepare Coordination Drawings as follows:
 - 1. Coordination drawings shall be required in the following areas:
 - a)
- L. Mechanical Contractor will prepare the base plan Coordination Drawings showing the building, all ductwork and all pertinent piping and equipment. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the owner and the architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.
- M. Mechanical Contractor will provide prints and CAD drawings and submit the base plan to all major trades' Contractors.
- N. Electrical, Plumbing and Fire Protection Contractors will draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.
- O. All offsets, elbows, duct/pipe transitions, air vents, drains and accessories required to accommodate field changes found during coordination drawings are the responsibility of the contractor at NO additional cost.

P. Coordination meetings will be held as necessary as determined by the architect.

END OF SECTION 23 0005

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to work in this section.

1.02 SUBMITTALS

- A. Schedule of valves and service.
- B. Product data for all valves.

1.03 REFERENCE STANDARDS AND CODES

- A. All installations and materials shall conform to applicable 2020 New York State Building Code, and local building and plumbing codes.
- B. All installations shall conform to requirements of Owner's Insurance carriers.
- C. Refer to the latest edition and applicable sections of the following:
 - 1. Underwriters Laboratories (UL)
 - 2. American Society of Testing and Materials (ASTM)
 - 3. American National Standards Institute (ANSI)
 - 4. American Society of Mechanical Engineering (ASME)
 - 5. Code for Pressure Piping B31.9 - Building Services Piping
 - 6. American Welding Society (AWS)
 - 7. National Fire Protection Association (NFPA)
 - 8. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS)

1.04 GENERAL REQUIREMENTS

- A. Ensure valves are dry and internally protected against rust and corrosion. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.
- B. Protect valve ends against damage to threads, flange faces and weld-end preps.
- C. Do not use hand-wheels and stems as lifting or rigging points.
- D. All valves and terminal water specialties shall be same size as upstream piping, unless otherwise indicated.
- E. Furnish valves with pressure and temperature ratings as specified and required to suit system pressures and temperatures.
- F. Furnish valves with either threaded, flanged or solder-joint end connections as specified.
- G. Furnish chain wheel operators for valves 6" and larger when valve is to be mounted 8' or higher above finished floor elevations.

PART 2 - PRODUCTS

2.01 VALVE SCHEDULE

A. Note: Specialty valves specified in other sections.

	Pipe Fill	Pipe Size	Valve Type
1.	Heating Hot Water	Up to 2"	BV-1
2.	Heating Hot Water	2-1/2" & Over	WV-1
3.	Heating Hot Water	Up to 2"	CBV-1
4.	Heating Hot Water	2-1/2" & Over	CBV-2
5.	Heating Hot Water	Up to 2"	CKV-1
6.	Heating Hot Water	2-1/2" & Over	CKV-2
7.	Chilled Water	Up to 2"	BV-1
8.	Chilled Water	2-1/2" & Over	WV-1
9.	Chilled Water	Up to 2"	CBV-1
10.	Chilled Water	2-1/2" & Over	CBV-2
11.	Chilled Water	Up to 2"	CKV-1
12.	Chilled Water	2-1/2" & Over	CKV-2
13.	Steam (30 psig & above)	Up to 2"	GV-3
14.	Steam (30 psig & above)	2-1/2" & Over	GV-4
15.	Steam (below 30 psig)	Up to 2"	GV-1
16.	Steam (below 30 psig)	2-1/2" & Over	GV-2
17.	Steam Throttling (30 psig & above)	Up to 2"	GLV-3
18.	Steam Throttling (30 psig & above)	2-1/2" & Over	GLV-4
19.	Steam Throttling (below 30 psig)	Up to 2"	GLV-1
20.	Steam Throttling (below 30 psig)	2-1/2" & Over	GLV-2
21.	Steam Condensate	Up to 2"	BV-1
22.	Steam Condensate	2-1/2" & Over	WV-2
23.	High Temp. Hot Water	Up to 2"	GV-3
24.	High Temp. Hot Water	2-1/2" & Over	GV-4
25.	Condensate Drain	Up to 2"	BV-1
26.	Condensate Drain	2-1/2" & Over	WV-1
27.	Cold Water Makeup	Up to 2"	BV-1
28.	Cold Water Makeup	Up to 2"	CKV-1
29.	Cold Water Makeup	2-1/2" & Over	CKV-2
30.	Cold Water Makeup	2-1/2" & Over	WV-1
31.	Cooling Tower Water	Up to 2"	BV-1
32.	Cooling Tower Water	2-1/2" & Over	WV-1

B. Valve Types

1. BV-1: Ball valve, size as required, sweat or threaded ends, forged bronze body, hard chrome plated ball, glass reinforced durafill seats, PTFE stem packing, 600 psi WOG non-shock, 150psi WSP for 1/4"-2", 450°F (@50psi) maximum temperature. Brass body is not acceptable and will be rejected. Series #B6000, B6001, Watts Regulator Co.; or equal.

2. CBV-1: Circuit balancing valve, size as required for nominal 3ft WG pressure drop. Note: the submitted pressure drop shall not exceed 2ft. The TAB contractor shall balance to 3ft. Y-pattern Style design and all metal parts of nonferrous, pressure die cast, nonporous Ametal copper alloy and high strength resin hand-wheel and sleeve. Provides a positive shut-off. Provision for connecting a portable differential pressure meter. Each meter connection shall have pressure/ temperature readout ports. Rubber O-ring disc to ensure positive shut-off. Valve shall provide multi-turn, 360° adjustment, digital handwheel with hidden memory feature to set the valve with precision tamper-proof setting. Model STAD, rated at 300 psig, 250°F, TA Hydronics; or equal.
3. CBV-2: Circuit balancing valve, size as required for nominal 2 ft WG pressure drop. Flanged, Y-pattern Style design with ductile iron body and other metal parts of nonferrous copper alloy and high strength resin hand-wheel and sleeve. Provides a positive shut-off. Provision for connecting a portable differential pressure meter. Each meter connection shall have pressure/ temperature readout ports. Rubber O-ring disc to ensure positive shut-off. Valve shall provide multi-turn, 360° adjustment, digital handwheel with hidden memory feature to set the valve with precision tamper-proof setting. Model STAF, rated at 250 psig, 250°F, TA Hydronics; or equal.
4. CKV-1: Check valve, bronze body, bronze disc. rated at 200 psi, non-shock for 2" and smaller. Nibco Model #T-413; or equal.
5. CKV-2: Check valve, iron body, bronze disc. rated at 200 psi, non-shock, flanged connections for 2-1/2" and larger. Nibco Model #F-918; or equal.
6. FCV-1: **ADJUSTABLE** Automatic flow control valves. Valve gpm shall be factory set and shall automatically limit flow to within 5% of specified rate. For 3/4" to 2" valves flow cartridge shall be removable from valve housing without the use of special tools to provide access without breaking main piping. Cartridge flow rates shall be externally adjustable while system is in operation with 41 flow rate settings range per cartridge. A true design operating pressure (psid) range of 4.4 – 58 psi is required. Each valve should have 2 P/T ports. All automatic flow control valves shall be provided by single source with certified flow tests. Internal wear surfaces of the valve cartridge shall be stainless steel. The cartridge body shall have machined threads to compensate for the spring free height. Fixed shims are not acceptable. Cartridges shall be color coded to determine model type and GPM Range and a flow rate chart for external adjustment of flow rate settings shall be provided. For 3/4" to 2" valves, valve assembly shall consist of Y type body and O-ring union. 2-1/2" to 6" valves shall be flanged wafer style valves and shall be externally adjustable while system is in operation with 51 flow rate settings per valve insert. Static pressure rating of 580 psi with a temperature rating of 248 F. Valve shall be E-just, by FlowCon International.; B&G; or approved equal. **NOTE: It is the intent that an externally adjustable valve is used to simplify installation, so the balancer can set the flow and ensure that the correct flow is achieved.**

7. FCV-2: **NON-Adjustable**, Automatic flow control valves. Valve gpm shall be factory set and shall automatically limit flow to within 5% of specified rate. For 3/4" to 2" valves flow cartridge shall be removable from valve housing without the use of special tools to provide access without breaking main piping. A true design operating pressure (psid) range of 4.4 – 58 psi is required. Each valve should have 2 P/T ports. All automatic flow control valves shall be provided by single source with certified flow tests. Internal wear surfaces of the valve cartridge shall be stainless steel. The cartridge body shall have machined threads to compensate for the spring free height. Fixed shims are not acceptable. Cartridges shall be color coded to determine model type and GPM Range and a flow rate chart for external adjustment of flow rate settings shall be provided. For 3/4" to 2" valves, valve assembly shall consist of Y type body and O-ring union. 2-1/2" to 6" valves shall be flanged wafer style valves. Static pressure rating of 580 psi with a temperature rating of 248 F. Valve shall be Griswald K-valve; or approved equal.
8. GLV-1: Globe valve, size as required, Class 150, bronze body, renewable composition disc, threaded ends, Figure #B29, Stockham Valve Co.; or equal. Provide Babbitt adjustable Sprocket Rim, complete with guide arm, guard ring, rust proof chain. Furnish with chain length as shown on drawing. Figure #659, #656, Jenkins Co.; or equal.
9. GLV-2: Globe valve, size as required, Class 125, iron body, renewable seat and disc, flanged ends, rated for steam, Figure #613, Jenkins Co.; or equal.
10. GLV-3: Globe valve, size as required, Class 250, bronze body, renewable composition disc and bronze seat ring, threaded ends, Figure #801, Jenkins Co.; or equal.
11. GLV-4: Globe valve, size as required, Class 250, iron body, renewable seat and disc, bronze disc and seat ring, rated for steam, flanged ends, Figure #923, Jenkins Co.; or equal.
12. GV-1: Gate valve, size as required, Class 125, bronze body, solid wedge, traveling stem threaded ends, rated for steam, rated at 200 psig and 353 F, T-113, Nibco; or equal.
13. GV-2: Gate valve, size as required, Class 125, iron body, OS & Y, flanged ends, bronze trim, rising stem, rated for steam service, Figure #F-617, Nibco; or equal.
14. GV-3: Gate valve, size as required, Class 200, bronze body, monel seats, bronze wedge, rising stem, threaded ends, Figure #B-144, Stockham Valve Co.; or equal.
15. GV-4: Gate valve, size as required, Class 300, steel body, OS & Y, flanged ends, bolted bonnet, Figure #30-GPFU-S, Stockham Valve Co.; or equal.
16. ROM-1: Provide a portable computerized balancing instrument capable of indicating pressure differential and temperature measurement across a system component. Instrument to contain a micro computer and a sensor unit with pressure sensor, measurement valve and connections. TA Hydronics Model TA CBI; or approved equal. Contractor shall provide (1) unit per project and turn over to Owner at project completion.
17. WV-1: Butterfly valve (HW, CHW as indicated) 2" – 12" size as required,. One piece cast iron **LUG** style body ANSI class 125/150, extended neck, Stainless Steel disc with polished edges, one piece stainless steel stem, triple function molded-in EPDM seat, upper and lower stem bearings, NBR (Buna) upper stem seal, bubble-tight shutoff, temperature range of -20o F to 250o F, pressure rating of 250 psi bi-directional. Keystone Figure 222; or equal.
 - a) Grooved end valve: 300 psi CWP suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be electroless nickel plated ductile iron with

blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full 360 degree seating. Seat shall be pressure responsive EPDM. Valve shall be complete with ISO flange for actuation mounting. Valve operators shall be lever handle or gear operator, available with memory stop feature, locking device, chainwheel, or supplied bare. Basis of Deign: Victaulic S/761

18. WV-2: Butterfly valve (HTHW, LPS as indicated), size as required. High performance valve, double off-set design, carbon steel body, lug type, 316SS disc and 17-4SS stem, RTFE seat, TFE packing, Temperature range up to 500o F, and pressure rating of 285 PSI bi-directional. Keystone Figure 36 or equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install all valves per manufacturers recommendations.

END OF SECTION 23 0523

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS:

- A. Description of intended testing procedures.
- B. Blank data forms indicating all intended test data points.
- C. Written statement of coordination with sheetmetal contractor.
- D. Written statement of coordination with piping contractor.
- E. Written statement of acceptance of location and quantity of air and water balancing devices.
- F. Pre-balance information from existing systems, where required.

1.03 QUALIFICATIONS

- A. Acceptable Subcontractors are:
 - 1. Member contractors of "Associated Air Balance Council".
 - 2. Member contractors of "National Environmental Balancing Bureau".
- B. Procedures and Methods: Follow written procedures published, one or more of following:
 - 1. Associated Air Balance Council (AABC).
 - 2. National Environmental Balancing Bureau (NEBB).

1.04 SCOPE OF WORK

- A. Contractor shall perform testing, balancing and adjusting work on all new and existing equipment shown on plans, listed in this section and as required by applicable sections of the specification.
Note: All existing equipment used in new or renovated systems is required to be tested adjusted and balanced.
- B. Note: Air side systems shall be balanced prior to water balance.
- C. Testing, adjusting and balancing is required for all of the following:
 - 1. Air Side Equipment:
 - a) Air Handling Units
 - b) Supply, Return, Exhaust and Relief Duct Systems
 - c) Terminal Equipment
 - d) Diffusers, Registers and Grilles
 - 2. Hydronic Equipment:
 - a) Pumps
 - b) Air Handling Unit Coils
 - c) Terminal Equipment Coils
 - d) Piping Distribution Systems
 - e) Terminal Radiation Units

1.05 GENERAL REQUIREMENTS

- A. It shall be responsibility of the Contractor to place all systems in satisfactory operating condition, including providing services of approved adjusting and balancing subcontractor regularly engaged in this type of work.
- B. Furnish set of Bid Documents to subcontractor within ten (10) days after award of contract.
- C. Adjusting and balancing shall be accomplished as soon as possible after systems are complete and before Owner takes possession.
- D. All systems must conform with the following noise criteria:
 - 1. Areas shall have NC30 to 35.
- E. Initial adjustment and balancing to quantities indicated on design drawings and thereafter as required to satisfy job conditions to satisfaction of the Architects.
- F. Adjusting and balancing shall be accomplished under appropriate outdoor temperature conditions.
- G. Immediately prior to subcontractor's arrival on project:
 - 1. Adjust all balancing cocks and dampers open.
 - 2. Place all equipment in operating condition.
 - 3. Clean all strainers.
 - 4. Remove all temporary air filters and install design filters.
- H. During course of the adjusting and balancing work:
- I. Maintain qualified personnel at project at all times for system operation, trouble shooting, assistance, etc.
- J. Change pulleys and belts as required to meet system performance requirements. Adjustable sheaves shall not be operated at extreme end of adjustment. Replace adjustable sheaves with proper size to operate approximately in mid-range.
- K. Perform necessary mechanical adjustments in conjunction with balancing procedure.
- L. Replace all flow balancers in new and existing systems that cannot be manipulated to satisfy balancing requirements.

1.06 JOB VISIT

- A. Balancing subcontractor shall visit job prior to concealment of work and advise location of dampers, test connections, etc.; advise Architects by letter.
- B. Make any changes or additions of types, locations, etc. of balancing facilities.

1.07 FINAL REPORT

- A. Upon completion, all information shall be inserted in report form listing all items required by specifications. Entire report shall be typewritten and shall be submitted to Architect and Engineer for approval. Results shall be guaranteed. Provide (3) hard copies and electronically submit to architect.

- B. Complete balancing analysis on all individual equipment and systems as specified shall be included in report.
- C. Contractor shall be subject to recall to site to verify report information before approval of report by Architects.
- D. Record action taken to adjust all systems to meet design specifications.
- E. Report on condition of installations (i.e. - complete/inoperative etc.)
- F. Final reports which do not contain all data required by this section will be rejected. Contractor will be required to retest and resubmit for all applicable systems with missing information.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide all tools, ladders, recording meters, gauges, thermometers, velometers, anemometers, Pitot tubes, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, psychrometers, tachometers, etc. required to execute the work. Instruments used shall be accurately calibrated.
1. **NOTE: IF VFD IS PROVIDED, CONTRACTOR SHALL USE VFD FOR BALANCING OF AIR OR HYDRONIC EQUIPMENT. SYSTEM TO BE BALANCED WITH TDV COMPLETELY OPEN.**

PART 3 - EXECUTION

3.01 AIR AND HYDRONIC SYSTEMS

- A. Preparation:
 1. Examine bid documents and notify Architects of any questions regarding balancing, within 30 days after receipt of bid.
 2. The balancing subcontractor shall review sheetmetal shop drawings and mark the location of all required balancing dampers before duct fabrication.
 3. Written notice of coordination between Contractor and balancing contractor to be submitted to Architect and Engineer.
- B. Requirements for Air-Side Testing, Adjusting & Balancing:
 1. Air Handling Equipment:
 - a) Record all drive information (i.e. - sheave type, belt size, motor data).
 - b) Test and adjust fan rpm to design requirements.
 - c) Record RPM and final sheave position.
 - d) Test and record motor no load, and full load amperes, and determine operating brake horsepower.
 - e) Test and record inlet and discharge static pressures.

- f) Test, adjust and record SA, RA, OA and relief air flows for design recirculated air cfm.
 - g) Test, adjust and record SA, RA, OA and relief air flows for full design outside air cfm. Make special effort to test and record total relief cfm air.
 - h) Test and record entering and leaving air temperatures. (D.B. heating and cooling)
 - i) Test and record equipment sound levels in closest occupied space.
2. Ductwork & Air Distribution Systems:
- a) Adjust all main supply, exhaust and return air ducts to proper design cfm, supply, exhaust, return and relief.
 - b) Test and adjust each diffuser, grille, and register to within 10% of design requirements.
 - c) After grilles, diffusers and registers are set at final CFM, check and record sound levels at occupant level at all locations.
 - d) Each grille, diffuser, and register shall be identified as to location and area.
 - e) Size, type and manufacturer of diffusers, grilles and registers, and all tested equipment shall be identified and listed; manufacturer's ratings on all equipment shall be used to make required calculations.
 - f) Readings and tests of diffusers, grilles and registers shall include required fpm velocity and test resultant velocity, required cfm and test resultant cfm after adjustments.
3. Terminal Units:
- a) Adjust terminal units to cfm.
4. Fans (Supply & Exhaust):
- a) Record all drive information (i.e. - sheave type, belts, size, motor data).
 - b) Test and adjust fan rpm to design requirements.
 - c) Record cfm, rpm and final sheave position.
 - d) Test and record motor no load and full load amperes and determine operating brake horsepower.
 - e) Test and record inlet and discharge static pressures.
 - f) In cooperation with control manufacturer's representative, make mechanical adjustments of automatically operated dampers to operate as specified, indicated, and/or noted; subcontractor shall check these damper control operations for proper calibrations and list those requiring adjustment by control installers.
 - g) All diffusers, grilles and registers shall have air patterns adjusted to minimize drafts in all areas.

- h) A record of all final settings shall be made, preferably at each piece of equipment by an appropriate approved mark or if necessary by description on the report schedule.
- i) Record all space temperatures. If space temperatures vary more than 2°F from thermostat setting readjust air flows to obtain proper temperature.

C. Requirements for Water Systems Testing, Adjusting & Balancing:

1. Initial Procedure:

- a) Examine bid documents and notify Architects of any questions regarding balancing, within 30 days after receipt of bids.
- b) Air systems shall be examined first.
- c) Open all manual valves to full open position; close coil bypass stop valves; set automatic control valves to full coil flow.
- d) Examine water in system and determine if water has been treated and cleaned.
- e) Check expansion tank and/or compression tanks to determine if they are not air bound or water logged and system is full of water and a proper minimum fill pressure.
- f) Check all air vents at high points of water systems and determine if they are installed and operating freely.
- g) Balance terminal units furthest from pumps, work towards pumps. Final balance pump flow control valve(s) last.

2. Pumps:

- a) Prior to balancing ensure all strainers and dirt pockets have been cleaned.
- b) Check pump rotation.
- c) Set hot water pumps to proper gallons per minute delivery.
- d) Record and check the following items at each heating element:
 - (1) Pressure drop across bypass valve.
 - (2) Pump operating suction and discharge pressures & final TDH.
 - (3) List all mechanical specifications of pumps.
 - (4) Rated and actual running amperage of pump motor.

3. Piping Distribution System:

- a) Test and adjust all flow control devices.
- b) Record final settings and distribution gpm.
- c) Test and record pressure on non adjustable flow control valves. Verify pressure is within control range on valve.

4. Hydronic Coils (HW, CHW):

- a) Set all temperature controls so all coils are calling for full flow.

- b) After adjustments to coils are made, recheck settings at pumps and readjust as required.
 - c) Read pressure and differential across coils and set flow rate on coil for full heating; set pressure drop across bypass valve to match coil full flow pressure drop.
 - d) Record and check the following items at each heating element:
 - (1) Inlet water temperature.
 - (2) Leaving water temperatures.
 - (3) Pressure drop.
 - e) Check water temperatures at outlet side of heating coils; Note: drop of temperature from source.
 - f) Upon completion of flow reading and adjustment of coils, mark all settings and record data. Show on schematic sketch form wherever practical.
5. Heat Exchangers:
- a) Check operation of any automatic bypass or diverting valves.
 - b) Check and set operating temperatures of heat exchanger to design requirements.
 - c) Record all flows, pressure drops and temperature across heat exchanger.
6. Fin Tube Radiation:
- a) Test, adjust and record gpm for fin tube unit.
 - b) For units not equipped with balancing valve, adjust flow across fin tube using temperature drop method.
 - c) Record flows or temperature drop readings and flow calculations.

3.02 STEAM SYSTEMS

A. Preparation:

- 1. Examine bid documents and notify Architects of any questions regarding balancing, within 30 days after receipt of bids.
- 2. Air systems shall be balanced first.

B. Initial Procedure:

- 1. Open all manual valves to full open position; close coil bypass stop valves; set automatic control valves to full coil flow. Examine steam in system and determine if desired flow is attainable.
- 2. Set all temperature controls so all coils are calling for full flow.
- 3. Check operation of any automatic bypass or diverting valves.
- 4. Check all steam traps and determine they are installed and operating freely.

C. Flow Adjustments:

1. Check steam temperatures at outlet side of heating coils; Note: drop of temperature from source.
2. Upon completion of readings and adjustment at coils, mark all settings and record data. Show on schematic sketch form wherever practical.
3. Fin radiation balancing valves shall be set by temperature drop across the fin. Drop shall be consistent with drop and heat output as specified herein.

D. Final Check:

1. After procedure is complete, thoroughly clean all strainers, dirt pockets, traps, etc.

END OF SECTION 23 0593

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 WORK INCLUDED

- A. Insulate all ducts and as required by contract documents.

1.03 REFERENCES

- A. Test standards and reports for evaluating and rating performance of fire rated shaft enclosures and zero inch clearance ratings for duct wrap systems for compliance to Code.
 - 1. ISO 6944-1985, 'Fire Resistive Tests - Ventilation Ducts'.
 - 2. ASTM E 2336, 'Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems'.
 - 3. ASTM E 814 (UL1479), 'Fire Tests of Through-Penetration Fire Stops Standard'.
 - 4. ASTM E 84, 'Standard Test Method for Surface Burning Characteristics of Building Materials'.
 - 5. ASTM C 1338, 'Fungi Resistance of Insulation Materials and Facings Standard'.
 - 6. NFPA 96 'Standard for Ventilation Control & Fire Protection of Commercial Cooking Operations'.

1.04 SUBMITTALS

- A. Manufacturer data for all materials used in contract. Submit schedule of insulation applications.

PART 2 - PRODUCTS

2.01 DUCTWORK INSULATION

- A. **NOTE: IF A CONDITION IS NOT LISTED BELOW, IT SHALL BE INSULATED WITH 2" RB.**
- B. All exhaust fan and relief hoods shall have the void between the duct and the curb completely insulated with FB insulation.
- C. All relief/intake hoods, goosenecks, louvered penthouses and any other ductwork that has exterior termination that have exposed surfaces inside the building shall be insulated as outside air ductwork.

D. The following is a schedule for ductwork insulation:

	Duct System & Location	Type	Thickness	Notes
1.	Outside Air, Relief Air, and Exhaust Air Ducts & Plenum Exposed to Air at Outside Ambient Temperatures (For All Air Handling and Energy Recovery Units), Energy Recovery Exhaust:			
	a) Concealed Spaces	FB	3"	(2)
	b) Exposed Spaces	RB	2"	(1)
2.	Supply & Return Duct:			
	a) Concealed Spaces	FB	2.2"	(2)(4)
	b) Exposed Spaces	RB	2"	(1)(4)
3.	Return Duct within a plenum ceiling	NONE		(6)
4.	Exhaust Fan Ductwork	FB	3"	(2)(5)
	a) Between the backdraft or mechanical damper and the space (ductwork having room conditioned ductwork), no insulation is required. All other exhaust ductwork (or if there is no damper present) shall be insulated as outside air ductwork.			
	b) This does not apply to energy recovery units, refer to above for all energy recovery units.			
5.	Crawlspace	FB	2.2"	(2)(3)
6.	Kitchen Exhaust & Grease Duct	FRI	3"	(1)
7.	Duct Coils (coil & duct 3'-0" min. upstream & downstream, including the coil)	FB	2.2"	(2)
8.	VAV coils (boxes are lined, coils need to be insulated)	FB	2.2"	(2)
9.	All Exterior Ductwork	ERB	3"	(3)(7)(8)(9)

Schedule Notes [some notes might not be used]:

- (1) Weld pins with tapered joints.
- (2) Stapled edge with mechanical fasteners on ducts over 24" wide.
- (3) Provide insulation whether duct is lined or not
- (4) Ducts with internal liner do not require additional insulation unless otherwise noted. This does not apply to special 14 gauge supply duct.
- (5) Exhaust duct exposed to air at ambient temperature must meet the requirements listed above.
- (6) Provide continuous, water tight jacketing over all exterior ductwork.
- (7) For ductwork over 24" wide, pitch insulation towards sides of duct.
- (8) Pitch insulation at equipment connections away from equipment to prevent pooling and intake of water.
- (9) Exterior insulation is not required on return ductwork contained within areas with a ceiling acting as a plenum return – provide exterior insulation per schedule on return ductwork when outside of areas of plenum return.

- E. Duct insulating materials shall be as follows:
1. FB: Flexible fiberglass blanket type duct wrap with factory applied foil faced jacketing reinforced with fiberglass scrim laminated to UL rated kraft. Minimum thickness = 2.2in. Insulation shall be 1-lb/ft³ with a thermal conductivity (k-value) of 0.27 Btu x in/(hr x ft² x °F) at 75°F mean temperature when compressed. Provide with 2" stapling tab. Provide Type #75, Johns Manville; or equal.
 2. FRI: Fireproof insulating material, non-asbestos, biosoluble, patented inorganic fire resistant blanket duct wrap insulation encapsulated with a scrim-reinforced foil, blanket thickness of 1.5" for kitchen exhaust grease duct applications marked with manufacturer's logo and UL and Intertek markings. Design use limit of 2192°F. Flame spread <25; smoke developed <50. Maximum flame spread 0 and smoke developed 0. R value of 4.15 and density of 6 pcf. Insulation shall be UL listed for 2 hour barrier. Duct wrap by 3M Fire Protection Products Duct Wrap 615+; or equal. Use with tape: High performance filament tape, 1" wide. Aluminum foil tape: 4" wide (for sealing cut blanket edges and seams). 3M No. 898; or equal.
 - a) UL 2221 – Standard for tests of fire resistive grease duct enclosure assemblies.
 - b) UL 1978 – Standard for grease ducts.
 - c) NFPA 96 – Standard for ventilation control and fire protection of commercial cooking operations.
 - d) NFPA-90A – Standard for the installation of air conditioning and ventilating systems.
 3. RB: Factory fabricated rigid fiberglass board with factory applied white kraft facing bonded to aluminum foil, reinforced with fiberglass yarn. Minimum thickness = 2in. Temperature limit 450°F unfaced side, 3.0 lb./cu. ft. density. Thermal conductivity (k-value) of 0.23 Btu x in/(hr x ft² x °F) at 75°F mean temperature. Insulation to have a R value of 4.3 per inch. Type #814, Johns Manville; or equal.
 4. ERB: Furnish and install 3" thick, closed-cell polyisocyanurate foam core board with foil facing on all ductwork segments and fittings installed outside of the building. Board shall have a R-value of 19 (for a 3" thick sheet). Board shall act as a vapor barrier with a vapor permeance of 0.05 perms. Provide Johns Manville AP Foil Faced; or equal.
- F. Jacketing Material shall be Venture Clad 1579GCW-E as manufactured by Venture Tape; or approved equal. To be applied over all exterior ductwork insulation or exterior lined ductwork, and as noted elsewhere.
1. Jacketing material shall have a 24.0 mils thickness, 13-ply embossed aluminum made with (2) layers of aluminum foil, a layer of polyester film, an outer layer of tedlan film and an acrylic pressure sensitive adhesive layer.
 2. Jacketing material to provide a 10 year membrane warranty, to be UV resistant and have zero permeability.

PART 3 - EXECUTION

3.01 INSTALLATION OF DUCTWORK INSULATION

- A. All insulation, jacketing and accessories are to be installed in strict accordance with manufacturer's instructions.

- B. Flexible Blanket Insulation (FB): Insulation shall be tightly wrapped around ductwork with all circumferential joints butted and longitudinal joints overlapped minimum of 2".
1. Adhere insulation to metal with 4" wide strips of insulation bonding adhesive at 8" on center and, on ductwork over 24" wide, additionally secure insulation to bottom with pins welded to duct 18" on center. On circumferential joints, secure 2" flange of facing using 9/16" flare door staples applied 6" on center and tape with 3" wide foil reinforced kraft tape. On longitudinal joints, secure overlap in the same manner. All pin penetrations or punctures in facing shall be similarly taped. If single blanket or sufficient thickness is not available, install two layers of equal thickness with vapor barrier facing on outer layer only.
- C. Fireproof Insulating Material (FRI): Install two layers of 1.5" thick wrap with 4" overlap applied directly to the duct. Overlap perimeter and longitudinal joints 3" or 4" on both layers. Fiberglass filament tape may be used as a temporary hold until metal banding is in place on exterior layer. Install fire resistive duct wrap insulation in direct contact with ductwork to manufacturer's instructions and referenced standards. For duct widths greater than 24", weld insulation pins to bottom of horizontal ducts on a 12"x10.5" maximum grid spacing. Welded insulation pins to one of the wider sides of all vertical ducts on a 12"x10.5" maximum grid spacing. Impale duct wrap insulation over pins and secure with speed clips to prevent blanket sag. At duct access doors: Install duct wrap to manufacturer's instructions and procedures. Firestopping at fire separations:
1. Firestop all wrapped ductwork penetrating fire rated concrete floors, gypsum board, block and concrete wall assemblies and gypsum board shaftwall assemblies using UL and/or Intertek firestop system listings appropriate for the applicable duct wrap system.
 2. Kitchen exhaust grease ducts: Fire resistive duct wrap insulation to be continuous through wall or floor penetrations. Maximum 3" clearance permitted between outer layer of duct wrap insulation and edge of opening. Fill annular space between edge of opening and wrapped duct with pieces of 3M duct wrap insulation or mineral wool insulation firmly packed into opening. Compress to percentage stated in firestop listing to minimum depth of 4". Recess packing material below surface on both sides of walls or top side only for floors to depth stated in firestop listing. Seal over packing material using 3M firestop sealant to depth stated in firestop listing, flush with top side of floor and both sides of wall surfaces.
- D. Rigid Board Insulation (RB): Impale insulation over pins welded to duct on 21" centers, cut to extend 1/8" beyond face of board and cover with vapor seal mastic and self-locking cap. Seal all edges and butt joints with 5" wide strips of self-sealing pressure sensitive tape matching surface and finish of duct insulation.
- E. Exterior Ductwork Insulation. Polyisocyanurate Board (ERB): Apply adhesive according to manufacturer's recommended coverage rates per area. Insulation to be adhered to ductwork with weld pins with tapered joints and adhesive, see below. Impale insulation over pins welded to duct on 21" centers, cut to extend 1/8" beyond face of board and cover with vapor seal mastic and self-locking cap. Seal all edges and butt joints with 5" wide strips of self-sealing pressure sensitive tape matching surface and finish of duct insulation. Insulation is to be applied to ductwork with joints tightly butted. All joints shall be fitted to eliminate voids. Any voids are to be eliminated by refitting or replacing sections of insulation.
1. Provide polyisocyanurate board on top, sides and bottom of duct with adhesive.
 2. For ducts over 24", apply sloped polyisocyanurate insulation (Hunter board H-shield; or equal) over Polyisocyanurate insulation to provide a 12/1 pitch in the center of the duct to prevent snow buildup. Attach Polyisocyanurate insulation together with adhesive.

3. Insulate bottom of duct first, full width of duct.
 4. Insulate sides next, same height as duct plus thickness of bottom sheet insulation.
 5. Insulate top full width of duct plus thickness of side sheets both sides.
 6. This contractor shall have a manufacturer's insulation representative instruct his personnel on the installation of this insulation and must be on the site the first day to review the installation.
- F. Jacketing: Jacket to be applied to all surfaces of insulation and duct. Jacket to overlap previous section by minimum of 2".

END OF SECTION 23 0713

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 SUBMITTALS

- A. Schedule of all materials used.
- B. Product data for all materials.

1.03 WORK INCLUDED

- A. Insulate all pipes as required by contract documents.

PART 2 - PRODUCTS

2.01 PIPING INSULATION

- A. **NOTE: IF A CONDITION IS NOT LISTED BELOW, IT SHALL BE INSULATED WITH 1-1/2" TYPE A OR TYPE B, DEPENDING ON THE PIPE.**

- B. The following is a schedule for pipe insulation:

		Pipe Diameter		Type	Notes
		Up To 1-1/4"	1-1/2" & Larger Insulation		
System Type		Min. Insulation Thickness			
1.	Steam (Low Pressure)	2"	3"	A	(1)(2)(3)(6)
2.	Steam (High Pressure)	2"	3"	C	(1)(2)(3)(6)
3.	Condensate	2"	3"	A	(1)(2)(3)(6)
4.	Heating Hot Water	1-1/2"	2"	A	(1)(2)(3)(5)(6)
5.	High Temp Hot Water	2"	3"	C	(1)(2)(3)(6)
6.	Chilled Water	1-1/2"	1-1/2"	A	(1)(2)(3)(5)(6)
7.	Dual Temp	1-1/2"	2"	A	(1)(2)(3)(5)(6)
8.	Condensate Drain	1/2"	1/2"	B	(4)
9.	Condenser Water	1/2"	1"	A	(1)(2)(3)
10.	Cold Water Make-up	1/2"	1/2"	A	(1)(2)
11.	Refrigerant Suction, Liquid Piping and Hot Gas Bypass				
	a) INTERIOR	1/2"	1/2"	B	(4)(7)
	b) EXTERIOR	1"	1"	B	(4)(5)

Schedule Notes:

- (1) Pre-Molded PVC Fitting Covers: Zeston, Inc.; or equal.
- (2) Self-seal lap.
- (3) Staples-outward clinching.
- (4) Foamed plastic pipe insulation adhesive; Armstrong Co.; 520 adhesive; or equal as required to ensure there are no gaps in insulation.

- (5) Exterior insulation shall be covered with exterior jacketing (venture clad) as specified hereinafter. All piping shall be supported to prevent sagging of the pipe, provide supports as required.
- (6) Furnish high impact strength PVC piping jacketing, as specified hereinafter, for all exposed piping in all finished spaces.
- (7) Provide manufacturers pre-insulated line sets with flare connections where possible. Provide rubber insert cushy clamps for all unistrut piping risers and hydra-zorb insulation unistrut cradles for horizontal piping. Ensure all piping is insulated with no gaps.

C. Equipment Insulation:

1. All hot water and chilled water fittings, valves, water specialties, flanges, air separators and pumps shall be insulated per this section, NO EXCEPTIONS!
2. Note: Do not run any insulation through pitch pockets.
3. Note: All insulation requirements of this section shall apply to flexible expansion joints (EXP-1).

2.02 MATERIALS FOR PIPING INSULATION

A. Pipe insulating materials shall be as follows:

1. Type A: Fiberglass pipe insulation jacketed with a reinforced vapor retarder jacket and factory applied longitudinal acrylic adhesive closure system. Insulation shall have a maximum service temperature of 850°F with a thermal conductivity (k-value) of 0.23 Btu x in/(hr x ft² x °F) at 75°F mean temperature per ASTM C518 and UL rated for maximum flamespread of 25 and smoke developed of 50. Johns Manville. Micro-Lok; or equal.
2. Type B: Closed Cell Foam Pipe Insulation. Insulation shall have a maximum service temperature of 300°F with a thermal conductivity (k-value) of 0.28 Btu x in/(hr x ft² x °F) at 75°F mean temperature per ASTM C518 and UL rated for a maximum flamespread of 25 and smoke developed of 50.
 - a) Pre-slit foamed plastic pipe insulation with slit positioned at side and vapor sealed with adhesive on all joints. AP Armaflex Tube Insulation; or equal.
3. Type C: High Temp. Pipe Insulation. Johns Manville, Thermo-12/Gold calcium silicate; or equal. Insulation shall have a maximum service temperature of 1,200°F with a thermal conductivity (k-value) of 0.37 Btu x in/(hr x ft² x °F) at 100°F mean temperature per ASTM C518 and UL rated for a maximum flamespread of 0 and smoke developed of 0.

B. High Impact Strength Jacketing: Furnish PVC jacketing and fitting covers, conforming to ASTM E-84; flame spread 25, smoke developed 50, white high gloss finish, 0.02" minimum thickness.

C. Furnish pre-molded PVC jacketing and fitting covers, lo-smoke type, as manufactured by Proto Corp.; or an approved equal.

D. Exterior Jacketing: Material shall be Venture Clad 1579GCW-E as manufactured by Venture Tape; or approved equal. To be applied over all exterior piping, and as noted elsewhere.

1. Jacketing material shall have a 24.0 mils thickness, 13-ply embossed aluminum made with (2) layers of aluminum foil, a layer of polyester film, an outer layer of tedlan film and an acrylic pressure sensitive adhesive layer.

2. Jacketing material to provide a 10 year membrane warranty, to be UV resistant and have zero permeability.

PART 3 - EXECUTION

3.01 PIPING INSULATION INSTALLATION

A. Type of Insulation Listed and Methods of Installation:

1. Fiberglass Pipe Insulation (A): Butt joints sealed with 3" wide strips of jacket material with factory applied pressure sensitive adhesive, laps and strips applied over clean dry surfaces and all longitudinal and circumferential seams rubbed hard with blunt steel edge. Cover valves, fittings, flanges, etc. with pre-formed fiberglass fittings and premolded PVC plastic jackets.
2. Closed Cell Foam Pipe Insulation (B): Insulate fittings, valves and flanges with mitered and fitted sections of foamed plastic pipe insulation positioned and fastened by adhesive on all joints.
3. Calcium Silicate Pipe Insulation (C): Secure insulation with stainless steel bands at 12-inch (300-mm) intervals, and tighten bands without deforming insulation materials. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Special Requirements:

1. Heating piping hangers shall be applied directly to piping. Cut-out insulation for hanger and cover with jacketing. Insulation shall be "butt-up" to hanger as tightly as possible.
2. Cooling/refrigeration piping insulation shall be continuous and have no breaks, insulation shield shall be applied between insulation and hanger.

END OF SECTION 23 0719

PART 1 – GENERAL

1.01 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents. Consult the above for further instructions pertaining to this work. The Contractor is bound by the provisions of Division 0 and Division 1.

1.02 STATE CONTRACT

- A. All controls will be by _____ under state contract.
- B. This section applies to the portion of _____ equipment and controls that will be supplied for this project via _____'s NYS OGS contract.
- C. Equipment will be shipped FOB factory and will be unloaded, inspected, stored, and installed by the Mechanical Contractor.
- D. The pre-purchased _____ equipment and _____ controls shall include start-up services, temperature controls, control engineering, controls installation and wiring, operating manuals, training and warranty for parts on equipment and controls. See other specification sections for additional requirements. All other warranty services are by the installing contractor.

1.03 CONNECTION TO EXISTING CONTROL SYSTEM (*If Necessary*)

- A. All new control equipment must integrate seamlessly with existing _____ DDC system. All new digital controllers are required to communicate fully with the existing temperature control network.
- B. All new controllers provided under this project must be connected to the existing BAS System. Extend network (including software) as required to provide a fully integrated control system.
- C. BAS System Contractor shall modify programming in host computer to accept all new equipment and I/O points.
- D. Contractor must visit site to inspect existing equipment required for operation of new systems. If existing miscellaneous equipment is not of sufficient size or is not functioning properly, contractor must include replacement or refurbishment in his bid.

1.04 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. XXX
 - 2. XXX
- B. If the Contractor is proposing to provide a product by a Manufacturer other than those listed above, the Contractor must, at least 10 days prior to bid opening, to obtain the approval of the Owner for the equal manufacturer, along with provided 5 references of sites where the company has performed projects to similar type.

1.05 SOFTWARE UPGRADES / SERVER UPGRADES

- A. At the completion of the project, the contractor shall ensure that all software is at its latest available revision and that all hardware (servers, workstations, laptops, etc.) shall be capable of meeting all requirements to ensure that the (OWNER) has been furnished with a completely updated system.
- B. If replacement of existing hardware is required due to compatibility with the latest revision of software, it shall be the responsibility of this contractor to provide new hardware.

1.06 CONTROL SYSTEM DESCRIPTION

- A. Provide labor, controls materials, controls equipment and services as required for a complete BACnet Building Automation System (BAS), to perform the functions described in this Section. Controls System shall be Web-based and accessible either directly connected and/or through the owners IP LAN network.
- B. It is the BAS manufacturer's responsibility to provide all the design, engineering, and field coordination required to ensure all equipment sequence of operations are met as specified and the designated BAS operators have the capability of managing the building mechanical system.
- C. The BAS shall meet BACnet communication standards to ensure the system maintains "interoperability" to avoid proprietary arrangements that will make it difficult for the Owner to consider other BAS manufacturers in future projects. These open protocol communication standards are discussed in more detail later in this specification.
- D. BAS controllers shall be listed by BACnet Testing Laboratories (BTL) with appropriate classification.
- E. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems and equipment on this project.
- F. The BAS shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by the security permissions of the operator role. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the control system and have access to all appropriate data.
- G. The BAS manufacturer shall provide all hardware and software necessary to implement the functions and sequence of operations specified.

1.07 SUBMITTAL REQUIREMENTS

- A. BAS manufacturer shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software being provided for this project. No work may begin on any segment of this project until the Engineer has reviewed submittals for conformity with the plan and specifications. Five (5) copies are required. All shop drawings shall be provided to the Owner electronically once they have been approved and as-built drawings have been completed.
- B. Quantities of items submitted shall be reviewed by the Engineer. Such review shall not relieve the BAS manufacturer of furnishing quantities required based upon contract documents.
- C. Provide the Engineer with any additional information or data which is deemed necessary to determine compliance with the specifications or which is deemed valuable in documenting and understanding the system to be installed.

- D. Submit the following within 45 days of contract award:
1. A complete bill of materials of equipment to be used indicating quantities, manufacturers and model numbers.
 2. A schedule of all control valves including the valve size, pressure drop, model number (including pattern and connections), flow, CV, body pressure rating, and location.
 3. A schedule of all control dampers including damper size, pressure drop, manufacturer, and model number.
 4. Note: schedule of valves and dampers shall be submitted independently of other submittals; do not combine with other submittals.
 5. Provide all manufacturers' technical cut sheets for major system components. When technical cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Include:
 - a) Building Controllers
 - b) Custom Application Controllers
 - c) Application Specific Controllers
 - d) Operator Workstations
 - e) Portable Operator Terminals
 - f) Auxiliary Control Devices
 6. Room schedule including a separate line for each VAV box and/or terminal unit indicating location and address.
 7. Samples of graphic display screen types and associated menus.
 8. Provide proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements.
 9. Provide detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls provided by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.
 10. Provide points list showing all system objects and the proposed object names.
 11. Provide a sequence of operation for each controlled mechanical system and terminal end devices.
 12. Provide a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet system level device (i.e. Building Controller & Operator Workstations) type. This defines the points list for proper coordination of interoperability with other building systems if applicable for this project.
- E. Project Record Documents: Upon completion of installation, submit PDF of record (as-built) documents. The documents shall be submitted for approval prior to final completion and include:
1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings. One set of electronic drawing files shall be provided.

2. Testing and Commissioning Reports and Checklists signed off by trained factory (equipment manufacturers) and field (BAS) commissioning personnel.
3. Operating and Maintenance (O & M) Manuals - These shall be as-built versions of the submittal product data. In addition to the information required for the submittals, Operating & Maintenance manual shall include:
 - a) Names, address and 24-hour/7-day per week telephone numbers of Contractor personnel managing and installing equipment, along with service personnel responsible for supporting the ongoing warranty and services of the control system.
 - b) Procedures for operating the BAS including logging on/off, alarm management, generation of reports, trends, overrides of computer control, modification of setpoints, and other interactive system requirements.
 - c) Description of the programming language including syntax, statement descriptions, algorithms, calculations, point database creation and modification, program creation and modification, and operator use of the editor.
 - d) Explanation of how to design and install new points, new DDC controllers, and other BAS hardware.
 - e) Preventative Maintenance and calibration procedures; hardware troubleshooting; and hardware repair and/or replacement procedures.
 - f) Documentation of all software program logic created for Custom Programmable Controllers including the overall point database. Provide one set of magnetic media containing files of the software and point database.
 - g) One set of electronic media containing files of all operator color graphic screens for the project.
 - h) A list of recommended spare parts including pricing, manufacturer, supplier, and part numbers.
 - i) Documentation, installation, and maintenance information for all third party hardware/software products provided including personal computers, printers, hubs, sensors, valves, etc.
 - j) Original issue media for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
 - k) Licenses, Guarantee, and Warranty documents for all equipment and systems.

1.08 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 232113 – Hydronic Piping

1. Control Valves
2. Temperature Sensor Wells and Sockets
3. Hydronic Pressure Taps
4. Hydronic Flow Meters

B. Section 233300 – Ductwork Accessories

1. Automatic Dampers
2. Airflow Stations

1.09 DEFINITIONS

Term	Definition
UCP	Unitary Controller
ACP	Air Handler Controller
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
Control Systems Server	A computer(s) that maintain(s) the systems configuration and programming database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers.
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Local Area Network	Computer or control system communications network limited to local building or campus.
Master-Slave/Token Passing (MS/TP)	Data link protocol as defined by the BACnet standard.
Point-to-Point	Serial communication as defined in the BACnet standard.
Primary Controlling LAN	High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
Protocol Implementation Conformance Statement (PICS)	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Router	A device that connects two or more networks at the network layer.
Wiring	Raceway, fittings, wire, boxes and related items.

1.10 CODES AND STANDARDS

- A. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.
1. Underwriters Laboratories: Products shall be UL-916-Energy Management Systems for BAS components & ancillary equipment
 2. Underwriters Laboratories: Products shall be UL-873 Temperature Indication & Regulating Equipment.
 3. Federal Communications Commission –Part 15- Subpart J.
 4. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National Standards.
 5. ASHRAE/ANSI 135-2012 (BACnet) - (System Level Devices) - Building Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

6. ASHRAE/ANSI 135-2012 (BACnet) - (Unit Level Devices) - Unit Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

1.11 QUALITY ASSURANCE

A. BAS Manufacturer Qualifications

1. The BAS manufacturer shall have an established business office within 100 miles of the project site and must provide 24 hours/day, 7 days/week response in the event of a customer warranty or service call.
2. The BAS Manufacturer shall have factory trained and certified personnel providing all engineering, service, startup, and commissioning field labor for the project from their local office location. BAS manufacturer shall be able to provide training certifications for all local office personnel upon request.
3. The BAS shall be provided by a single manufacturer and this manufacturer's equipment must consist of operator workstation software, Web-based hardware/software, Open Standard Protocol hardware/software, Custom application Programming Language, Graphical Programming Language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (i.e., sensors, valves, dampers, actuators, etc.) need not be manufactured by the BAS manufacturer listed in this specification.

1.12 SYSTEM PERFORMANCE

A. Performance Standards. The BAS system shall conform to the following:

1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 10 seconds of the operator's request.
2. Graphic Refresh. The system shall update all dynamic points with current data within 10 seconds.
3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 5 seconds. Analog objects shall start to adjust within 5 seconds.
4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current within the prior 10 seconds.
5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 10 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

8. Multiple Alarm Annunciations. All workstations on the network shall receive alarms within 5 seconds of each other.
9. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.
 - a) Table 1: Reporting Accuracy (*applicable to the project*)

Measured Variable	Reported Accuracy
Space Temperature	±1°F
Ducted Air	±2°F
Outside Air	±2°F
Water Temperature	±1°F
Delta –T	±0.25°F
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Air Flow (terminal)	±10% of reading
Air Flow (measuring stations)	±5% of reading
Air Pressure (ducts)	±0.1 "W.G.
Air Pressure (space)	±0.01 "W.G.
Water Pressure	±2% of full scale *Note 1
Electrical Power	5% of reading *Note 2
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO2)	± 50 PPM

Note 1: for both absolute and differential pressure

Note 2: * not including utility supplied meters

1.13 WARRANTY REQUIREMENTS

A. Warranty all work as follows:

1. BAS system labor and materials shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BAS manufacturer shall respond to the Owner's request for warranty service within 24 hours of the initiated call and will occur during normal business hours.
2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the BAS is operational, and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.
3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by the Owner must be granted prior to the installation of these updates.
4. The BAS manufacturer shall provide a web-accessible Users Network for the proposed System and give the Owner free access to question/answer forum, user tips, upgrades, and training schedules for a one year period of time correlating with the warranty period.

1.14 SYSTEM MAINTENANCE

- A. Perform Building Automation System preventative maintenance and support for a period of 1 year (beginning the date of substantial completion).
 - 1. Make a minimum of 2 complete Building Automation System inspections, in addition to normal warranty requirements. Inspections to include:
 - a) System Review – Review the BAS to correct programming errors, failed points, points in alarm, and points that have been overridden manually.
 - b) Seasonal Control Loop Tuning – Control loops are reviewed to reflect changing seasonal conditions and/or facility heating and cooling loads.
 - c) Sequence of operation verification – Systems all verified to be operating as designed and in automatic operation. Scheduling and setpoints are reviewed and modified.
 - d) Database back-up
 - e) Operator coaching
 - 2. Technician shall review critical alarm log and advise owner of additional services that may be required.
 - 3. Technician shall provide a written report to owner after each inspection.
- B. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of owner.

1.15 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project specific software and documentation shall become the owner's property upon project completion.

1.16 SEQUENCE OF OPERATION

- A. Unit Shut Down
 - 1. All units connected to FACP shall be shut down in the event of fire. (By EC via fire alarm system).
 - 2. All units with low limit controllers (freezestats) shall be shut down if supply air temperature drops below 35°F. Shut down includes closing OA dampers, shut down fan, open control valve (or face damper).
 - 3. All low limit controls shall be hard wired to break fan controls. Wiring low limit through DDC is not permitted to break fan controls. Wiring from LC-1 to DDC system is for alarm purposes only.
 - 4. When low limit control is activated, send auxiliary alarm signal to DDC unit controller. DDC system shall annunciate alarm condition.
 - 5. **All temperature control valves and dampers will be spring return and shall fail to the "Safe" position for that system.**

6. **Bypass valve application will be size for 50% of the pump capacity of that system.**
- B. Remote Monitoring:
1. Provide all software necessary to monitor all sensors, equipment status and alarm conditions at operate workstation and local second tier controllers.
 2. Provide all software necessary to recognize, process and record alarm conditions as required by Owner.
- C. Occupied/Unoccupied Cycle:
1. Each system with DDC controls shall function as an individual D/N zone with individual event times for start/stop.
 2. Stagger initial start times to prevent simultaneous occupied cycle activation for all equipment.
 3. In unoccupied cycle, when room sensor override button is pushed, start software timer (setpoint 2 hours) to provide Day (occupied) cycle for a software selectable period of time after which system reverts to Night (unoccupied) cycle.
 4. While software timer is operating ignore additional override switch signals. System shall ignore switch signals initiated when area is in occupied cycle.
- D. Morning Warm-Up: Provide software routine to initiate morning warm-up when outdoor conditions dictate, warm-up schedule shall be adaptive (i.e. optimize energy usage). During morning warm-up for classrooms and shop areas with motion detector, the detector is overridden until room occupied temperature setpoint is reached, duration (2) hours (adjustable).
- E. Refer to drawings for unit specific sequences.

PART 2 – PRODUCTS

2.01 GENERAL DESCRIPTION

- A. The Building Automation System (BAS) shall use us an open BACnet architecture and DDC controllers that are certified by BACnet Testing Laboratories (BTL) with the appropriate classifications. The BAS shall be capable to integrae to third-party devices and applications. The system shall be for use on the the Internet, or intranets using off the shelf, industry standard technology compatible with the owner provided network.
- B. The Building Automation System (BAS) shall consist of the following:
1. BACnet Testing Laboratories Certified Controllers
 2. Portable Operator Terminal(s)
 3. Networking processing, data storage, and communications equipment
 4. Other controls components required for a complete and working BAS
- C. The Building Automation System (BAS) shall be modular in nature, and shall permit expansion of both capacity and functionality through addition of sensors, controllers, actuators, and operator devices, whilre reusing existing controls equipment.

2.02 BAS ARCHITECTURE

A. Communication Network

1. This project shall be comprised of a high speed Ethernet network utilizing BACnet/IP communications between System Controllers and Workstations. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall be as defined below.
2. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using BACnet/Zigbee (802.15.4) as defined by the Zigbee Standard.
 - a) Each communication interface shall be Zigbee Building Automation Certified product as defined by the BACnet Standard and the Zigbee Alliance.
 - b) Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system.
 - c) Wireless equipment controllers and auxiliary control devices shall conform to:
 - (1) IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.
 - (2) Communication between equipment controllers shall conform to ZigBee Building Automation (ZBA) standard as BACnet tunneling devices to ensure future integration of other ZBA certified devices.
 - (3) Operating range shall be a minimum of 200 feet (60 m); open range shall be 2,500 ft. (762 m) with less than 2% packet error rate.
 - (4) To maintain robust communication, mesh networking and two-way communications shall be used to optimize the wireless network health.
 - (5) Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.
 - (6) Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E.
3. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using BACnet/MSTP (RS485) as defined by the BACnet standard.

B. Integrator Panel:

1. The BAS System shall include appropriate hardware equipment and software to allow bi-directional data communications between the BAS and the 3rd Party manufacturers' control panels. The BAS shall receive, react to, and return information from multiple building systems, including equipment manufacturers' integral packaged controls that do not have the BACnet protocol.
2. All data required by the application shall be mapped into the BAS database, and shall be transparent to the operator.
3. Point inputs and outputs from the third-party controllers shall have real-time interoperability with the BAS such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, and Local Area Network Communications.

BACNET Protocol Integration:

4. The neutral protocol used between systems will be BACnet and must comply with the ASHRAE BACnet standard 135.
 5. A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
 6. The ability to command, share point object data, change of state data, and schedules between the host and BACnet systems shall be provided.
- C. The Controls Contractor shall provide all communication media, connectors, repeaters and network switches routers necessary for the high speed Ethernet communications network.

2.03 OPERATOR USER INTERFACE

- A. Furnish 1 PC based operator interface as shown on the system drawings. Each operator web interface shall be able to access all information in the system. Operator interfaces shall reside on the same dedicated high-speed IP network as the System Controller(s).
1. Each operator interface PC shall include the following:
 - a) Hardware type
 - (1) PC or Laptop
 - b. Minimum Hardware
 - (1) Pentium Core 2 DUO or better
 - (2) 4 GB RAM
 - (3) 100 GB hard drive space
 - c. Internet Browser compatibility outlined in the following sections.
- B. Operator web interface
1. The operator web interface shall be accessible via a web browser without requiring any “plug-ins” (i.e. JAVA Runtime Environment (JRE), Adobe Flash).
 2. The operator web interface shall support the following Internet web browsers:
 - a) Internet Explorer 11.0+
 - b) Firefox 47.0+
 - c) Chrome 51.0+
 3. System Security
 - a) Each operator shall be required to login to the system with a user name and password in order to view, edit, add, or delete data.
 - b) User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.
 - c) Each operator shall be allowed to change their user password.
 - d) The System Administrator shall be able to manage the security for all other users.
 - e) The system shall include pre-defined “roles” that allow a system administrator to quickly assign permissions to a user.

- f) User logon/logoff attempts shall be recorded.
 - g) The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.
 - h) All system security data shall be stored in an encrypted format.
 - i) The system shall support Active Directory for user set-up and management.
 - j) The system shall track and record all user log-in activity and all changes done at the enterprise level including who made the change, when, what was changed, previous value and new value.
4. Database
- a) Database Save: A system operator with the proper password clearance shall be able to archive controller back-ups on the designated Enterprise operator web interface PC.
 - b) Database Restore: The system operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
 - c) Database Limits. The system operator shall have the ability to set limits on Alarm Log, Global Point Control Log, System Log, and User Change Log to manage database size.
5. On-line Help and Training
- a) Provide a context sensitive, on line help system to assist the operator in operation and configuration of the system.
 - b) On-line help shall be available for all system functions and shall provide the relevant data for each particular screen.
6. System Diagnostics
- a) The system shall automatically monitor the operation of all network connections, building management panels, and controllers
 - b) The failure of any device shall be annunciated to the operators.
7. Customizable Navigation Tree
- a) The Enterprise operator web interface shall include a fully customizable navigation tree that shall allow an operator to do the following:
 - (1) Move and edit any of the nodes of the tree.
 - (2) Move entire groups to any area of the tree
 - (3) Change the name of any node in the tree
 - (4) Create custom nodes for any page in the web interface including graphics, data log views, schedules, and dashboards.
 - (5) Support navigation from multi-building to single building view.
 - (6) Provide the ability to assign graphics to any node in the tree.
 - (7) Ability to create folders and assign and change hierarchy of nodes of the tree.

8. Equipment & Application Pages
 - a) The Enterprise operator web interface shall include standard pages for all equipment and applications. These pages shall allow an operator to obtain information relevant to the operation of the equipment and/or application, including:
 - (1) Animated Equipment Graphics for each major piece of equipment and floor plan in the System.
 - (2) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
 - (3) Historical Data (As defined in Data Log section below) for the equipment or application without requiring a user to navigate to a Data Log page and perform a filter.
 - (4) View of all custom graphical programming for supported controllers in real time.
 - (5) View and management of all points for equipment and applications.
 - (6) Support documents that have been assigned for that equipment.
 - (7) Live data view for any selected points.
 - (8) Touch friendly design for all action buttons, navigation, and spacing.
9. System Graphics. Enterprise operator web interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using colors to represent zone temperature relative to zone set point.
 - a) Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point and-click navigation between zones or equipment, and to edit set points and other specified parameters.
 - b) Graphic imagery – graphics shall use 3D images for all standard and custom graphics. The only allowable exceptions will be photo images, maps, schematic drawings, and selected floor plans.
 - c) Animation. Graphics shall be able to animate by displaying different Image lies for changed object status.
 - d) Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - e) Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).
10. Custom Graphics
 - a) The operator interface shall be capable of displaying custom graphics in order to convey the status of the facility to its operators.
 - b) Graphical Navigation. The Enterprise operator web interface shall provide dynamic color graphics of building areas, systems and equipment.

- c) Graphical Data Visualization. The Enterprise operator web interface shall support dynamic points including analog and binary values, dynamic text, static text, and animation files.
 - d) Custom background images. Custom background images shall be created with the use of commonly available graphics packages such as Adobe Photoshop. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as GIF and JPEG.
- 11. Graphics Library. Furnish a library of standard MECHANICAL equipment such as chillers, air handlers, terminals, fan coils, unit ventilators, rooftop units, and VAV boxes, in 3-dimensional graphic depictions. The library shall be furnished in a file format compatible with the graphics generation package program.
- 12. Document Support. The Enterprise operator web interface shall support the ability to import support files into a support files library.
 - a) Imported support files can include the following types of document formats: pdf, docx, xlsx, pptx, jpeg, tif, bmp, png, jpg, gif.
 - b) All imported support files can be associated directly with equipment or family types that can then be accessed directly from standard pages.
- 13. Manual Control and Override
 - a) Point Control. Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status shall be available by menu, on graphics or through custom programs.
 - b) Temporary Overrides. The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.
 - c) Override Owners. The system shall convey to the user the owner of each override for all priorities that an override exists.
 - d) Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually.
 - e) Global Point Control. Provide a method for a user to view, override, and edit if applicable, the status of multiple object and properties in the system. The point status shall be available by menu, on graphics or through custom programs.
- 14. Engineering Units
 - a) Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.
 - b) Unit selection shall be able to be customized by locality to select the desired units for each measurement.
- 15. Scheduling. A user shall be able to perform the following tasks utilizing the Enterprise operator web interface:
 - a) Create a new schedule, defining the default values, events and membership.
 - b) Create expectations to a schedule for any given day.

- c) Apply an exception that spans a single day or multiple days.
- d) View a schedule by day, week and month.
- e) Exception schedules and holidays shall be shown clearly on the calendar.
- f) Modify the schedule events, members and exceptions.
- g) Create schedules and exceptions for multiple buildings.
- h) Apply emergency schedule to multiple buildings
- i) Drag and drop scheduling editing
- j) Global schedule and exceptions across multiple buildings

16. Time of day scheduling

- a) Individual time schedules shall be provided for all areas and as listed below. The schedules for each area shall operate independently and shall be configured to meet the requirements of the Owner. The start time of each area shall be configured with optimum start times software functions, stop times shall follow a simple off time schedule.

Areas	Approx. Occupied Time
Office Areas	06:30 - 17:00
Classroom	07:00 - 15:00
Library	07:00 - 15:00
Toilet Room Exhaust Fans	06:00 - 20:00
Gymnasium	09:00 - 15:00
Auditorium	09:00 - 15:00
Kitchen	06:00 - 1500
Open Area	07:00 - 17:00

Note: General equipment associated with a particular area shall follow the area start/stop time schedule (i.e. – classroom general exhaust fans shall stop @ 15:00).

17. Data Logs

- a) Data Logs Definition
 - (1) The Enterprise operator web interface shall allow a user with the appropriate security permissions to define a Data Log for any data in the system.
 - (2) The Enterprise operator web interface shall allow a user to define any Data Log options as described in the Application and Control Software section.
 - (3) Data Log viewing capabilities shall include the ability to show a minimum of 5 points on a chart.
 - (4) Each data point data line shall be displayed as a unique color.
 - (5) Data points can be hidden on the display view by clicking on the point.
 - (6) The operator shall be able to specify the duration of historical data to view by scrolling, zooming, or selecting from a pull down list.
 - (7) The system shall provide a graphical trace display of the associated time stamp and value for any selected point along the x-axis.
 - (8) Operator will have the ability to show alarms and overrides on any data log view.

- b) Export Data Logs
 - (1) The Enterprise operator web interface shall allow a user to export Data Log data in CSV, xlsx or text format for use by other industry standard word processing and spreadsheet packages.
- C. Central Server – Components (Provide server as required)
 - 1. The central physical or virtual server shall consist of the following (minimum):
 - 2. System shall utilize a server class PC, tower or rack mounted.
 - 3. Two 3.0 GHz, Quad Core
 - 4. 8GB, DDR266 SDRAM memory
 - 5. Hard Drive 73 GB
 - 6. RAID 5 (recommended)
 - 7. Microsoft Windows Server 2012/2014
 - 8. Microsoft SQL Server 2008/2012
 - 9. No Exception Taken Framework V3.5, 4.0
 - 10. TCP/IP Interface
- D. The central server shall provide the following applications within the system.
 - 1. Trend Log Application
 - a) The system shall automatically harvest trend logs for defined key measurements for each controlled MECHANICAL device and MECHANICAL application.
 - b) The automatic trend logs shall monitor these parameters for a minimum of 30 days at 15 minute intervals. The automatic trend logs shall be user adjustable.
 - 2. Site Management
 - a) The system must allow for grouping of the many sites in an enterprise in a logical manner.
 - b) The system shall provide a search function to allow users to search for sites or groups of sites by name or partial names.
 - c) The system must provide the necessary means to add, remove, and manage site.
 - 3. Automatic System Database Save and Restore
 - a) The central server shall store on the hard disk backup tables of data including trends, alarms, custom settings and user profiles.
 - b) The data shall be backed up once a day.
 - c) This database shall be updated whenever a change is made in the system.
 - d) The storage of this data shall be automatic and not require operator intervention.
 - e) This capability is completed through SQL scheduled automated tasks for backup and only available in full SQL, and not SQL Express.
 - 4. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to archive the database manually at any time.
 - 5. System Configuration. The central server shall serve web pages as the interface for configuring the operator-level functions of the system. A user with proper security shall be able to configure the system to allow for future changes or additions.

- E. Portable Operator's Terminal P.O.T (where indicated).: (Intended for portable field diagnostic tool.) Provide laptop computer with terminal emulation software to interface with DDC panels. Computer shall be Windows platform with latest stable windows operating system (Windows 8.1) integral pointing device. Furnish unit with all interface cards, cables, and software necessary to operate with DDC communications network, and to communicate directly with unit control panels. Furnish with (2) sets interface cables. Provide Windows 8.1 software. Schedule of laptop computer requirements:

Processing Chip	Pentium N3540, 2.5 GHz
RAM Memory	4 GB
Hard Drive	500 GB 5400 RPM
Two USB	USB 2.0 Ports and 3.0 Ports
Display	15" LED True Life HD
Video	HDMI Port
Sound	Maxx Audio
LAN Comm.	Ethernet Communications Board, 3COMM; or equal
Wireless Card	3-1 Memory Card Reader

- F. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the building operator interface.
1. Scheduling. Provide the capability to schedule each object or group of objects in the system based off of the owner's request. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:
 - a) Weekly Schedule. Provide separate schedules for each day of the week.
 - b) Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
 - c) Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
 - d) Optimal Start. The scheduling application outlined above shall support an optimal start algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.
 2. Trend Log Application
 - a) Trend log data shall be sampled and stored on the System Controller panel and shall capable of being archived to a BACnet Workstation for longer term storage.
 - b) Trend logs shall include interval, start-time, and stop-time.

- c) Trend log intervals shall be configurable as frequently as 1 minute and as infrequently as 1 year.
- 3. Trend Logs
 - a) The system controller shall create trend logs for defined key performance indicators for each controlled MECHANICAL device and MECHANICAL application.
 - b) The trend logs shall monitor these parameters for a minimum of 7 days at 15 minute intervals. The automatic trend logs shall be user adjustable.
- 4. Alarm/Event Log
 - a) Any object in the system shall be configurable to generate an alarm when transitioning in and out of a normal or fault state.
 - b) Any object in the system shall allow the alarm limits, warning limits, states, and reactions to be configured for each object in the system.
 - c) An alarm/event shall be capable of triggering any of the following actions:
 - (1) Route the alarm/event to one or more alarm log
 - (2) The alarm message shall include the name of the alarm location, the device that generated the alarm, and the alarm message itself.
 - (3) Route an e-mail message to an operator(s).
 - (4) Log a data point(s) for a period of time.
 - (5) Run a custom control program.
- 5. Point Control. User shall have the option to set the update interval, minimum on/off time, event notification, custom programming on change of events.
- 6. Timed Override. A standard application shall be utilized to enable/disable temperature control when a user selects on/cancel at the zone sensor, building operator interface, or the local operator display. The amount of time that the override takes precedence will be selectable from the building operator interface.
- 7. Anti-Short Cycling. All binary output points shall be protected from short cycling.
- 8. Alarm/Event Notification:
 - a) An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.
 - b) The operator will have the option of selecting an audible alarm notification for all alarm classes they subscribe to.
 - c) The system operator will have the option of setting specific times and days that that they will receive alarm notifications.
 - d) Provide software alarm points as listed below and as required by the Owner. Contractor shall meet with the Owner to include additional alarm point annunciation as requested by the Owner.

Point	Alarm Function
Hardware	Communication Failure Hardware Failure
Space Temperature	Out of Limits ($\pm 5^{\circ}$ from setpoint)
Duct Air Temperature	Out of Limits ($\pm 10^{\circ}$ from setpoint)
Water Flow Switch	Loss of Flow
Air Flow Switch	Loss of Flow
Water Temperature	Out of Limits ($\pm 10^{\circ}$ from setpoint)
Freeze Stat	Report Freeze Condition
Current Flow Switch	Loss of Current (Fan/Pump)

9. User Change Log. The operator shall be able to view all logged user changes in the system from any Enterprise operator web interface.
 - a) An operator shall be able to group user changes by: date, affected, date & affected, user, date & user, transaction type, date & transaction type, or sort only.
 - b) The operator will have the option of additional filtering capability of: date, transaction, type, user, affected, and details that can be used individually or in conjunction with other filters.

2.04 BUILDING CONTROLLERS

- A. There shall be one or more independent, standalone microprocessor based System Controllers to manage the global strategies described in Application and Control Software section.
 1. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 2. The controller shall provide a USB communications port for connection to a PC.
 3. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 4. All System Controllers shall have a real time clock.
 5. Data shall be shared between networked System Controllers.
 6. The System Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall.
 - a) Assume a predetermined failure mode.
 - b) Generate an alarm notification.
 - c) Create a retrievable file of the state of all applicable memory locations at the time of the failure.
 - d) Automatically reset the System Controller to return to a normal operating mode.
 7. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40°C to 50°C [-40°F to 122°F].

8. Clock Synchronization:
 - a) All System Controllers shall be able to synchronize with a NTP server for automatic time synchronization.
 - b) All System Controllers shall be able to accept a BACnet time synchronization command for automatic time synchronization.
 - c) All System Controllers shall automatically adjust for daylight savings time if applicable.
9. Serviceability
 - a) Provide diagnostic LEDs for power, communications, and processor.
 - b) The System Controller shall have a display on the main board that indicates the current operating mode of the controller.
 - c) All wiring connections shall be made to field removable, modular terminal connectors.
 - d) The System controller shall utilize standard DIN mounting methods for installation and replacement.
10. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller.
11. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage.
12. BACnet Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the BACnet Test Labs with a minimum BACnet Protocol Revision of 14.

2.05 ADVANCED APPLICATION CONTROLLERS

- A. Advance Application Controllers shall be used to control all equipment or applications of medium and high complexity, including but not limited to Air Handlers, Boiler Plants and Chiller Plants.
- B. For Stand-Alone Operation of Advanced Application Controllers:
 1. Shall operate a schedule in a standalone application using a Real Time Clock with a 7 day power backup.
 - a) The Controller shall have a built in schedule (assessable with or without a display).
 - b) Support will be for at least 3 schedules with up to 10 events for each day of the week.
 - c) Each of the 3 schedules can be Analog, Binary or Multi-State.
 - d) The controller shall support a minimum of 25 exceptions each with up to 10 events.
- C. For ease of troubleshooting, the Controller shall support data trend logging.
 1. 25,000 samples minimum

2. Trends shall be capable of being collected at a minimum sample rate of once every second.
 3. Trends shall be capable of being scheduled or triggered.
- D. To meet the sequence of operation for each application, the Controller shall use library programs provided by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.
- E. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
1. Storage conditions:
 - a) Temperature: -67°F to 203°F (-55°C to 95°C).
 - b) Humidity: Between 5% to 100% RH (non-condensing).
 2. Operating conditions:
 - a) Temperature: -40°F to 158°F (-40°C to 70°C)
 - b) Humidity: Between 5% to 100% RH (non-condensing).
 3. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.
 4. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40° F to 158° F [-40° C to 70° C].
- F. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment. In addition other controls must meet the following requirements.
1. Shall support flexibility in valve type, the controllers shall be capable of supporting the following valve control types: 0-10VDC, 0-5VDC, 4-20mA, 24VAC - 2 position.
 2. Shall support flexibility in sensor type, the Controller shall be capable of reading sensor input ranges of 0 to10V, 0 to 20mA, 50ms or longer pulses, 200 to 20Kohm and RTD input.
 3. Shall support flexibility in sensor type, all Analog Outputs shall have the additional capability of being programmed to operate as Universal Inputs or Pulse Width Modulation Outputs.
 4. Shall support flexibility in sensor type, the Controller and/or expansion modules shall support dry and wetted (24VAC) binary inputs.
 5. The controller shall support pulse accumulator for connecting devices like energy meters.
 6. In order to support a wide range of devices, the Controller's binary output shall be able to drive at least 10VA each.
 7. Any unused I/O that is not needed for the functionality of the equipment shall be available to be used by custom programs on the Controller and by any other controller on the network.
 8. The Controller shall provide 24VAC and 24VDC power terminals sensors and other devices required.
 9. The Controller shall provide a dedicated static pressure input.

- G. Input/Output Expandability – The Controller shall provide the following functionality in order to meet current and future application needs:
1. For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.
 2. Expansion I/O can be mounted up to 650 ft. (200m) from control.
 3. Expansion I/O can be added in as small as 4 point increments.
 4. To keep BACnet network traffic to a minimum, expansion I/O must communicate via an internal controller communication bus.
- H. Serviceability – The Controller shall provide the following in order to improve serviceability of the Controller.
1. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.
 2. Binary and analog inputs and outputs shall use removable connectors or be connected to terminal strip external to the control box.
 3. Software service tool connection through all of the following methods: direct cable connection to the Controller, connection through another controller on BACnet link and through the Controller's zone sensor.
 4. For safety purposes, the controller shall be capable of being powered by a portable computer's USB port for the purposes of configuration, programming and testing programs so that this work can be accomplished with the power off to the associated equipment.
 5. The Controller software tool service port shall utilize standard off-the-shelf USB printer cable.
 6. Capabilities to temporarily override the BACnet point values with built-in time expiration in the Controller.
 7. To aid in service replacement, the Controller shall easily attached to standard DIN rail mounting.
 8. For future expansion, the Controller shall be capable of adding sequence of operation programming utilizing service tools software with a graphical programming interface (editing or programming in line code is not permissible).
 9. To aid in service replacement, the Controller shall allow for setting its BACnet address via controller mounted rotary switches that correspond to the numerical value of the address. (DIP switch methodologies are not allowed). Setting of the address shall be accomplished without the need of a service tool or power applied to the controller.
 10. Controller data shall be maintained through a power failure.
- I. Software Retention: All Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.

- J. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.
- K. Controller must meet the following Agency Compliance:
 - 1. UL916 PAZX, Open Energy Management Equipment
 - 2. UL94-5V, Flammability
 - 3. FCC Part 15, Subpart B, Class B Limit
 - 4. BACnet Testing Laboratory (BTL) Listed.
- L. A Local Operator Touch Sensitive Display shall be provided for Central Plant and Air Handler Controllers at building locations where specified in the sequence of operations or point list.

2.06 APPLICATION-SPECIFIC CONTROLLERS

- A. Application Specific Controllers (ASC) shall be microprocessor-based DDC controllers which, through hardware or firmware design, control specified equipment. They are not user programmable, but are customized for operation within the confines of the equipment they are designed to serve.
 - 1. Application Specific Controller are only allowed when both the following are met.
 - a) The equipment is compressor based or boiler based.
 - b) The controller is provided by the equipment manufacturer and warrantied as part of the equipment.
- B. Zone Controllers are controllers that operate equipment that control the space temperature of single zone. Examples are controllers for VAV, Fan coil, Blower Coils, Unit Ventilators, Heat Pumps, and Water Source Heat Pumps.
 - 1. Software
 - a) To meet the sequence of operation for each zone control, the controller shall use programs developed and tested by the controller manufacturer that are either factory loaded or downloaded with service tool to the controller.
 - b) Stand-Alone Operation: Each piece of equipment specified in section "A" shall be controlled by a single controller and provide stand-alone control in the event of communication failure. In case of communications failure stand-alone operation shall use default values or last values for remote sensors read over the network such as outdoor air temperature.
 - c) For controlling ancillary devices and for flexibility to change the sequence of operation in the future, the controller shall be capable running custom programs written in a graphical programming language.
 - 2. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
 - a) Storage: -55° to 203° F and 5 to 95% Rh, non-condensing.
 - b) Operating: -40° to 158° F and 5 to 95% Rh, non-condensing.
 - c) Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.

- d) Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40° to 158° F.
3. Input/Output:
- a) For flexibility in selection and replacement of valves, the controllers shall be capable of supporting all of the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC floating point, 24VAC - 2 position (Normally Open or Normally Closed).
 - b) For flexibility in selection and replacement of sensors, the controllers shall be capable of reading sensor input ranges of 0 to 10V, 0 to 20mA, pulse counts, and 200 to 20Kohm.
 - c) For flexibility in selection and replacement of binary devices, the controller shall support dry and wetted (24VAC) binary inputs.
 - d) For flexibility in selection and replacement devices, the controller's shall have binary output which are able to drive at least 12VA each.
 - e) For flexibility in selection and replacement of motors, the controller shall be capable of outputting 24VAC (binary output), DC voltage (0 to 10VDC minimum range) and PWM (in the 80 to 100 Hz range).
 - f) For future needs, any I/O that is unused by functionality of equipment control shall be available to be used by custom program on the controller and by another controller on the network.
 - g) For future expansion and flexibility, the controller shall have either on board or through expansion, 20 hardware input/output points. Expansion points must communicate with the controller via an internal communications bus. Expansion points must be capable of being mounted up to 650ft. (200 m) from the controller. Expansion points that require the BACnet network for communication with the controller are not allowed.
4. Serviceability – The controller shall provide the following in order to improve serviceability of the controller.
- a) Diagnostic LEDs shall indicate correct operation or failures/faults for all of the following: power, sensors, BACnet communications, and I/O communications bus.
 - b) All binary output shall have LED's indicating the output state.
 - c) All wiring connectors shall removable without the use of a tool.
 - d) Software service tool connection through all of the following methods: direct cable connection to the controller, connection through another controller on BACnet link and through the controller's zone sensor.
 - e) For safety purposes, the controller shall be capable of being powered by a portable computer for the purposes of configuration, programming, and testing programs so that this work can be accomplished with the power off to the equipment.
 - f) Capabilities to temporarily override of BACnet point values with built-in time expiration in the controller.
 - g) BACnet MAC Address shall be set using decimal (0-9) based rotary switches.
 - h) Configuration change shall not be made in a programming environment, but rather by a configuration page utilizing dropdown list, check boxes, and numeric boxes.
 - i) BACnet trending objects resident on controller.
 - (1) Minimum of 20,000 trending points total on controller

- (2) Shall be capable of trending all BACnet points used by controller
 - (3) Shall be capable of 1 second sample rates on all points
5. Software Retention: All Zone Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.
 6. Transformer for the controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads, for a maximum of 12 VA for each binary output.
 7. Agency Approval: The controller shall have meet the Agency Compliance:
 - a) UL916 PAZX, Open Energy Management Equipment
 - b) UL94-5V, Flammability
 - c) FCC Part 15, Subpart B, Class B Limit

2.07 INPUT / OUTPUT INTERFACE

- A. Hardwired inputs and outputs may tie into the system through building, custom application, or ASCs.
- B. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.
- C. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
- D. Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.
- E. Analog inputs shall allow the monitoring of low voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary outputs shall provide for on/off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have status lights. Outputs shall be selectable for either normally open or normally closed operation.
- G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.
- H. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
- I. System Object Capacity. The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and

wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.08 POWER SUPPLIES

- A. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish overcurrent protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in overvoltage and overcurrent protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.
 - a. Line voltage units shall be UL recognized and CSA approved.

2.09 AUXILIARY CONTROL DEVICES

- A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:
 - 1. **(D-1)**: Opposed blade damper.
 - 2. **(D-2)**: Parallel blade damper.
 - 3. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.
 - 4. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.
 - 5. Damper shaft bearings shall be as recommended by manufacturer for application.
 - 6. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.
 - 7. All leakage testing and pressure ratings will be based on AMCA Publication 500.
 - 8. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.
 - 9. Control dampers shall be parallel or opposed blade types as scheduled on drawings.
 - 10. Acceptable Manufacturer shall be Ruskin, Greenheck, or equal.
- B. Electric damper/valve actuators **(ME-1, ME-2, ME-3)**
 - 1. ME-1: Modulating range.
 - 2. ME-2: Two Position.
 - 3. ME-3: Modulating range, for unit ventilators.

4. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
5. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.
6. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.
7. Actuators shall be Underwriters Laboratories Standard 873 listed.
8. Acceptable Manufacturer shall be Belimo or equal.

C. Control Valves

1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.
2. Size control valves according to chart below: (Maximum DP of 3 psi):

VALVE SIZE CHART		
Max GPM	VALVE SIZE	CV
7.5	1/2"	4.4
13	3/4"	7.5
24	1"	14
35	1-1/4"	20
48	1-1/2"	28
69	2"	40
113	2-1/2"	65
156	3"	156
294	4"	294

3. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a) Water Valves:
 - (1) Two-way: 150% of total system (pump) head.
 - (2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - b) Steam Valves: 150% of operating (inlet) pressure.
4. Water Valves
 - a) Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 - b) Sizing Criteria.
 - (1) **(CVI)** Two-position service.
 - (2) Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 3 psi, whichever is greater.

- (3) **(CVM, CVZM)** Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 3 psi maximum.
- (4) Valves (1/2 in.) through (2 in.) shall be bronze body or cast brass ANSI Class 250, spring-return, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball, 23°F - 250°F.
- (5) Valves (2 1/2 in.) and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing, globe valve.
- (6) Never provide a controls valve that is less than half the size of the supply line serving that system.

c) Terminal Unit Zone valves shall be sized to meet the control application and they shall be spring return so in the event of a power failure, they will go to full open.

5. Acceptable Manufacturer shall be Belimo; or equal

D. Binary Temperature Devices (**THL-1**)

1. Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover. Acceptable Manufacturer shall be Honeywell; or equal.
2. Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover. Acceptable Manufacturer shall be Honeywell; or equal.

E. Temperature Sensors (**TSB, TSR, TSD, TSDA, TS/HS**)

1. TSB: Flat plate thermistor room sensor. ACI R2; or equal.
2. TSR: Room sensor with LCD display and setpoint adjustability. ZS Pro-M, Automated Logic; or equal.
3. TSD/TSDA: duct mounted sensor.
4. TS/HS: Combination temperature and humidity sensor. A/RH1; Automation Components, Inc.
5. Combination Temperature and Humidity sensor.
6. Temperature sensors shall be RTD or thermistor.
 - a) Wireless space sensor component certifications shall include:
 - (1) UL 916 - Energy Management Equipment.
 - (2) UL 94 - The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances.
 - (3) UL 873 - Temperature regulating and indicating equipment.
 - b) The wireless space sensor battery life shall provide at least 15 years life under normal operating conditions and must be readily available size AA, 1.5V.

7. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m² (10 ft²) of duct cross section.
 8. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
 9. Space sensors shall be equipped with setpoint adjustment, override, display, and/or communication port as shown on plans.
 10. Provide matched temperature sensors for differential temperature measurement.
- F. Humidity Sensors (**HSTS-wall mount / HSP-duct mount**)
1. Space Humidity Sensors shall have a sensing range of 20% to 80% with accuracy of +/- 2% RH.
 2. Duct Sensors and Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH with an accuracy of +/- 2% RH.
 3. Humidity sensor's drift shall not exceed 1% of full scale per year.
 4. Acceptable Manufacturer shall be Omega; or equal.
- G. End Switch (**ES-1**)
1. Proof of closure of damper. Kele; or equal.
- H. Pressure Sensors (**DPT-1**)
1. Air pressure of differential pressure measurements in the range of 0 to 10" water column shall be accurate to +/- 1% of range. Acceptable Manufacturer shall be Setra; or equal.
 2. Liquid pressure or differential liquid pressure measurements shall be accurate to +/- 0.25% of range. Unit shall be provided with isolation and bypass manifold for startup and maintenance operations. Acceptable Manufacturer shall be Setra; or equal.
- I. Low Limit Thermostats (**LC-1**)
1. Safety low limit thermostats shall be vapor pressure type with an element 6m [20 ft] minimum length. Element shall respond to the lowest temperature sensed by any one foot section. Acceptable Manufacturer shall be Honeywell; or equal.
 2. Low limit shall be manual reset only.
- J. Carbon Dioxide Sensors (**CDS-1**)
1. Carbon Dioxide sensors shall measure CO₂ in PPM in a range of 50 ppm with drift not to exceed 20 ppm. Sensors shall be duct or space mounted as indicated in the sequence of operation.
 2. Acceptable Manufacturer shall be Dwyer; or equal.
- K. Flow Switches (**FS-1**)

1. Flow-proving switches shall be either paddle or differential pressure type.
2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125VA minimum) and shall have adjustable sensitivity with NEMA 1 enclosure unless otherwise specified. Manufacturer shall be Setra; or equal.
3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified. Acceptable Manufacturer shall be Setra; or equal.

L. Air Flow Probes (**AF-1**)

1. Provide an array of airflow traverse probes where indicated, capable of continuously monitoring the fan or duct capacities (CFM) they serve. Each airflow traverse probe shall contain multiple total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probe(s), and shall be the offset type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30°. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket and signal fittings suitable for MECHANICAL duct installation.
2. The airflow traverse probe shall not induce a pressure drop in excess of 0.03" w.c. at 2000 FPM, nor measurably contribute to sound levels within the duct. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular duct) or at equal concentric area centers (for circular ducts) along the probe length. The airflow traverse probe shall be capable of producing steady, non-pulsating signals of total and static pressure without need for flow corrections or factors, with an accuracy of 2-3% of actual flow, over a velocity range of 400 to 4000 FPM.
3. Provide the minimum number of probes indicated: Duct height 8 – 12", 1 probe; 13 – 30", 2 probes; 31 – 54", 3 probes; 55 – 84", 4 probes; 85 – 120", 5 probes; 121 – 180", 6 probes.
4. The airflow traverse probe shall be the VOLU-probe as manufactured by Air Monitor Corporation, or equivalent.

M. Hydronic Flow Meters (**FM-3**)

1. Insertion-Type Turbine Meter
 - a) Insertion type, complete with hot-tap isolation valves to enable sensor removal without water supply system shutdown.
 - b) Liquide flow measurement devices shall be accurate to +/- 1% over a turn down ratio of 10:1.
 - c) Each sensor shall be individually calibrated and tagged accordingly against the manufacturer's primary standards.
 - d) All wetted metal parts shall be constructed of 316 stainless steel.

- e) Analog outputs shall consist of non-interactive zero and span adjustments, a DC linearity of 0.1% of span, voltage output of 0–10 Vdc, and current output of 4–20 mA.
- f) Acceptable Manufacturer shall be Onicon; or equal.

N. Relays (**CR-1**)

- 1. Control relays shall be UL listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
- 2. Time delay relays shall be UL listed solidstate plug-in type with adjustable time delay. Delay shall be adjustable $\pm 200\%$ (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.
- 3. Acceptable Manufacturer shall be Functional Device Inc.; or equal.

O. Transformers and Power Supplies

- 1. Control transformers (**XT-1**) shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
- 2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.
- 3. Unit shall be UL recognized.
- 4. Acceptable Manufacturer shall be Functional Device Inc.; or equal.

P. Current Switches (**CFS-1**)

- 1. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.
- 2. Acceptable Manufacturer shall be Functional Device Inc.; or equal.

Q. Immersion Temperature Sensor (**ITS, ITS-1**)

- 1. Furnish with brass thermowell. Well insertion length to center of pipe. Glycol system require stainless steel well. ACI; or equal.

R. Motion Detector (**MDS-1**)

- 1. Ultra-sonic type omni directional transmitter, dual receivers, sensitivity gain control, 600 sq. ft. coverage, 24 Volt DC, Universal Energy Control Inc.; or approved equal.

S. Static Pressure Sensor (**SPS-1, SPNL-1**)

1. Model 264, pressure transmitter 4-20mA, 0-5VDC, 2.5VDC bidirectional output, 24VDC power by this Contractor, range 0-1.0" wg. or as applicable to individual systems needs. Setra; or approved equal.

T. Current transmitters

1. AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, with internal zero and span adjustment and $\pm 1\%$ full-scale accuracy at 500 ohm maximum burden.
2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
3. Unit shall be split-core type for clamp-on installation on existing wiring.
4. Acceptable Manufacturer shall be Functional Device Inc. or equal.

U. Power Monitors

1. Selectable rate pulse output for kWh reading, 4–20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0–0.33 volt inputs.
2. 1.0% full-scale true RMS power accuracy, +0.5 Hz, voltage input range 120–600V, and auto range select.
3. Under voltage/phase monitor circuitry.
4. NEMA 1 enclosure.
5. Current transformers having a 0.5% FS accuracy, 600 VAC isolation voltage with 0 - 0.33 V output. If 0–5 A current transformers are provided, a three-phase disconnect/ shorting switch assembly is required.
6. Acceptable Manufacturer shall be Allen-Bradley; or equal.

V. Push Button (**PB-1**)

1. Flush mount, stainless steel plate, mushroom head, contact block with red nameplate, white lettering to identify fan and purpose.

W. Thermal Energy Meters

1. Matched RTD or thermistor temperature sensors with a differential temperature accuracy of $\pm 0.15^\circ\text{F}$.
2. Flow meter that is accurate within $\pm 1\%$ at calibrated typical flow rate and does not exceed $\pm 2\%$ of actual reading over an extended 50:1 turndown range.
3. Unit accuracy of $\pm 1\%$
4. NEMA 1 enclosure.
5. UL listed.

6. Isolated 4–20 ma signals for energy rate and supply and return temperatures and flow.
 7. Acceptable Manufacturer shall be Onicon; or equal.
- X. Carbon Monoxide Sensor (**CDS-1**)
1. Wall mounted Carbon Monoxide Sensor (CO) shall monitor CO over a range of 0-300 PPM.
 2. The device shall have an accuracy of +/- 3% and operate within the range of 32-110 deg F and 0-95% RH.
 3. Acceptable Manufacturer shall be Honeywell; or equal.
- Y. Local Control Panels (**TCP, TCP-1**)
1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with hinged door, and removable sub-panels or electrical sub-assemblies.
 2. Interconnections between internal and face-mounted devices shall be pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
 3. Provide on/off power switch with over-current protection for control power sources to each local panel.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. The Contract Documents shall be thoroughly examined for coordination of control devices, their installation, wiring, and commissioning. Coordinate and review mechanical equipment specifications, locations, and identify any discrepancies, conflicts, or omissions that shall be reported to the Architect/Engineer for resolution before rough-in work is started.
- B. The BAS manufacturer shall inspect the jobsite in order to verify that control equipment can be installed as required, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

3.02 PROTECTION

- A. The BAS installation contractor shall protect all work and material from damage by their work or personnel, and shall be liable for all damage thus caused.
- B. The BAS manufacturer shall be responsible for their work and equipment until final inspection, testing, and acceptance. The BAS installing contractor shall protect their work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.03 COORDINATION

A. Site

1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
2. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

B. Submittals. Refer to the "Submittals," section of this specification for requirements.

C. Test and Balance

1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
2. The contractor shall provide training in the use of these tools. This training will be planned for a duration of 4 hours.
3. The tools used during the test and balance process shall be returned to the contractor at the completion of the testing and balancing.

D. Life Safety

1. Duct smoke detectors required for air handler shutdown shall be supplied under Division 26 contract. The contractor shall interlock smoke detectors to air handlers for shutdown as described in the Sequences of Operation for this project.

E. Coordination with Controls Specified in Other Sections or Divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:

1. All communication media and equipment shall be provided as specified in the "Communication" section of this specification.
2. Each supplier of a controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
3. The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.

F. Fire Alarm: Provide interface card to allow communications between temperature control network and fire alarm system. Coordinate exact requirements with Electrical Contractor. Provide all hardware and software necessary for full seamless interface. Show fire alarm failure on graphics.

3.04 GENERAL WORKMANSHIP

- A. Install equipment, piping, wiring/conduit, parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible locations as defined by National Electric Code (NEC). Control panels shall be attached to structural walls or properly supported in a free-standing configuration, unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.
- D. Verify integrity of all control wiring to ensure continuity and freedom from shorts and grounds prior to commencing the startup and commissioning procedures.
- E. All control device installation and wiring shall comply with Contract Documents, acceptable industry specifications, and industry standards for performance, reliability, and compatibility. Installation and wiring shall be executed in strict adherence to local codes and standard practices referenced in Contract Documents.

3.05 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Contract Documents.
- B. BAS manufacturer shall continually monitor the field installation for building code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.
- C. BAS installing Contractor(s) shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

3.06 WIRING

- A. All control and interlock wiring shall comply with the National, Local Electrical Codes, and Division 26 of these Contract Document specifications.
- B. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC requirements.
- C. All wiring in plenum spaces shall be enclosed in conduit. Plenum rated cable can be used in accessible ceilings.
- D. Where Class 2 wires are in concealed and accessible locations; including ceiling return air plenums, approved cables outside of electrical raceway can be used provided that the following conditions are met:
 - 1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
 - 2. All cables shall be UL listed for application (i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose).
 - 3. Line Voltage Control Wiring:

- a) For control relays or other low amperage circuits #14 AWG THHN.
 - b) For direct line voltage control of equipment minimum conductor size #12 AWG THHN.
 - c) Electronic Sensor Wiring: 18 AWG, stranded (16x30) copper conductors, twisted pair, 100% overall aluminum polyester shield, 20 AWG CU drain wire. Polyethylene insulation, PVC jacket, 300V, 60°C. Furnish Belden; or equal.
 - d) Computer Communications Cable: 18 AWG, stranded (16x30) copper conductors, (2) twisted pair, 100% individual aluminum polyester shields each shield with 20 AWG CU drain wire. PVC insulated, PVC jacket, 300V. Furnish Belden; or equal.
Note: Actual # of conductors may be increased as required for actual communication requirement.
4. Provide minimum (1) spare shielded twisted pair conductors in each communications wiring run. Wiring runs between operator work stations (if any) provide (2) spare shielded twisted pair conductors.
- E. Do not install Class 2 wiring in conduits containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two via control relays and transformers.
- F. Where Class 2 wiring is run exposed, wiring shall be conduit
- G. Maximum allowable voltage for control wiring shall be 120Vac. If only higher voltages are available for use, the BAS manufacturer shall provide step-down transformers to achieve the desired control voltages.
- H. All control wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- I. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with Contract Documents and National and/or Local Codes.
- J. Conduit and wire sizing shall be determined by the BAS manufacturer in order to maintain manufacturer's recommendation and meet National and Local Codes.
- K. Conduit Routing and termination
- 1. Conduits shall be installed so as to be concealed in all finished spaces at the conclusion of the project unless otherwise noted. Conduits may be exposed in mechanical and electrical rooms and unfinished storage, maintenance and production areas.
 - 2. Where it is impractical to conceal wiring or conduit in finished construction, cables shall be run in wiremold.
 - 3. Make neat runs parallel or perpendicular to structural elements (walls, ceilings, floors) of building with minimum number of couplings and bends. Install so that required conductors may be drawn without injury or excessive strain.

4. Provide double locknuts and insulation bushings on the end of each conduit entering an enclosure. If smaller holes are used in knockouts provide listed devices which overlap largest knockouts as required to strengthen the termination.
 5. Cap or plug open ends of conduits during construction.
 6. Conduits shall be continuous from equipment controls to cabinets, junction or pull boxes and shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous.
 7. Change in Direction of Conduit:
 - a) Concealed locations - use standard radius bend.
 - b) Exposed locations or concealed locations where conduit will be accessible; use standard radius bends or conduit body.
 8. Install conduits to allow proper drainage. Do not form pockets.
 9. Securely attach all conduits to building structure utilizing approved methods and fastening devices for support.
 10. Clear obstructions in raceways or replace raceways at no additional contract cost. Demonstrate to Architect that spare conduits are free of obstruction at substantial completion and leave a drag line (1/8" polypropylene monofilament utility rope) for future use.
- L. Follow manufacturer's installation recommendations for all communication and network bus cabling. Network or communication cabling shall be run separately from all control power wiring.
- M. Adhere to the Division 26 requirements for installation of electrical raceways.
- N. BAS manufacturer shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- O. Flexible metal conduits and liquid-tight flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.
- P. Penetrations:
1. Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways. All other project fire stopping to be by other trade.
 2. All openings in the fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
 3. All wiring passing through penetrations, including walls, shall be in conduit or enclosed raceway.
 4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true and square.
 5. No penetrations in structural elements shall be made before receipt of written approval from Engineer and/or Architect.

Q. BMS Raceway:

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 3/4".
2. Where it is not possible to conceal raceways in finished locations, surface raceway (wiremold) may be used as approved by the Engineer.
3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
4. Flexible metal conduit shall be used for vibration isolation and shall be limited to 3' in length when terminating to vibrating equipment. Flexible metal conduit may be used within partition walls. Flexible metal conduit shall be UL listed.

3.07 COMMUNICATION WIRING

- A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- B. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
- C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer shall not be exceeded during installation.
- D. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- E. When a cable enters or exits a building, a lightning arrestor must be installed between the line and ground.
- F. All runs of communication wiring shall be unspliced length when the length is commercially available.
- G. All communication wiring shall be labeled to indicate origin and destination.

3.08 FIBER OPTIC CABLE

- A. All cabling shall be installed in a neat and workmanlike manner. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.
- B. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post installation residual cable tension shall be within cable manufacturer's specifications.
- C. Fiber optic cabinets, hardware, and cable entering the cabinet shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

3.09 INSTALLATION OF SENSORS

- A. Sensors required for mechanical equipment operation shall be factory installed and wired as specified in mechanical equipment specifications. BAS manufacturer shall be responsible for coordinating these

control devices and ensuring the sequence of operations will be met. Installation and wiring shall be in accordance with the BAS manufacturer's recommendations.

- B. Sensors that require field mounting shall meet the BAS manufacturer's recommendations and be coordinated with the mechanical equipment they will be associated.
- C. Mount sensors rigidly and adequately for the environment the sensor will operate.
- D. Room temperature sensors shall be installed on concealed junction boxes properly supported by the block wall framing. For installation in dry wall ceilings, the low voltage sensor wiring can be installed exposed and must meet applicable National and Local Electrical Codes.
- E. All wires attached to wall mounted sensors shall be sealed off to prevent air from transmitting in the associated conduit and affecting the room sensor readings.
- F. Install duct static pressure tap with tube end facing directly down-stream of air flow.
- G. Install space static pressure sensor with static sensing probe applicable for space installation where applicable.
- H. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
- I. All pipe mounted temperature sensors shall be installed in matched thermowells. Install all liquid temperature sensors with heat conducting fluid in thermal wells for adequate thermal conductance.
- J. Wiring for space sensors shall be concealed in building drywall. EMT conduit is acceptable within mechanical equipment and service rooms.
- K. Install outdoor air temperature sensors on north wall complete with sun shield at manufacturer's recommended location and coordinated with Engineer.

3.10 IDENTIFICATION OF HARDWARE AND WIRING

- A. All field wiring and cabling, including that within factory mounted, and wired control panels and devices for mechanical equipment, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information for troubleshooting, maintenance, and service purposes. BAS manufacturer to coordinate this labeling requirement with mechanical equipment manufacturer as it relates to controls.
- B. Permanently label or code each point of field terminal strips to show the instrument or item served and correlate them to the BAS design drawings.
- C. Identify control panels with plastic nameplates.

3.11 GROUNDING AND BONDING

- A. Equipment Grounding Conductors: All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings. Equipment grounding conductors shall be green insulated copper conductors unless otherwise indicated.
1. Install green, equipment grounding conductor with all feeder and branch circuit conductors.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
 3. Enclosures: Ground all enclosures of electrical and electronic wiring and distribution equipment in accordance with requirements of the NEC Article 250.
 4. Equipment Enclosure Grounding: Bare wire, wrapped around connecting screws or mounting bolts and screws is not acceptable as a grounding connection. All ground lugs shall be of a noncorrosive material suitable for use as a grounding connection, and must be compatible with the type of metal being grounded. Ground lugs shall be mounted on clean, bare metal surfaces that are free of paint, rust, etc. Wire brush clean each surface to remove paint or oxidation prior to bolting jumper connectors in place. In general use tinned copper connectors for connections of dissimilar metals. Use of bimetal connectors shall only be allowed in special circumstances and only with the prior written approval.

3.12 CONNECTIONS

- A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Terminate insulated equipment grounding conductors for feeders with pressure-type grounding lugs. Where metallic raceways terminate at non-metallic or non-conductive housings, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.
- C. Raceway Grounding: Surface metal raceways, wireways, or cable trays or cable rack systems shall be installed in a manner that ensures electrical continuity. Short insulated green copper bonding jumpers shall be installed between adjacent raceway sections, on both sides of each joint, to ensure proper bonding. Unless otherwise indicated, the minimum size for these bonding jumpers shall be No. 6 AWG. Jumpers shall be provided with compression connectors at each end of cable. Surface metal raceways, wireways, cable trays or cable rack systems shall be field drilled to provide bolting point for securing bonding jumper. Wire brush clean each surface to remove paint or oxidation prior to bolting jumper connectors in place. Bolts and hardware shall be as per details or as approved for grounding purposes. All metallic raceway penetrations into a facility structure shall be bonded to the earth electrode system.

- D. Other Grounding Systems: Any additional grounding systems used for electronic equipment shall be connected to the facility main ground plate, structural steel or exterior earth electrode system as shown on drawings.
- E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with torque tightening values specified in UL 486A.

3.13 CONTROL SYSTEM CHECKOUT AND TESTING

A. Acceptance Check Sheet:

1. The contractor shall prepare check commissioning sheets that include all points for all functions of each system as indicated on the temperature controls submittal documents.
2. Submit the check sheets to the engineer for approval within the temperature controls submittal documents.
3. Engineer will use the approved check sheets as the basis for acceptance of the BAS.
4. The contractor is perform complete commissioning reports for this project. Prior to final payment, contractor must submit signed commissioning checklist, approved by both the owner and engineer. The contractor must also prepare commissioning reports for each piece of equipment that is being controlled.

B. Start-up testing. All testing in this section shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.

1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service all of the instruments, controls, and accessory equipment furnished under this specification.
2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturer's recommendations.
4. Verify all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starter, etc.) operate properly and normal positions are correct.
5. Verify all analog output devices (I/Ps, actuators, etc) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimal start/stop routines.
7. Alarms and Interlocks
 - a) Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

- b) Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction,
 - c) Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
- C. Start-up testing. All testing in this section shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.

3.14 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- A. Acceptance: The BAS will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's representative. Such tests shall then be performed as part of the warranty.

3.15 TRAINING

- A. Provide minimum of 2 classroom training sessions, and 4 hours for each session, throughout the contract period. The training will be provided for personnel designated by the Owner.
- B. Provide course outline and materials prior to schedule training session. The instructor(s) shall provide one copy of training material per student.
- C. The instructor(s) shall be factory-trained and experienced in teaching this technical material.

END OF SECTION 23 0993

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1 Specifications Section, apply to the work of this section.

1.02 SUBMITTALS

- A. Product data.

1.03 REMOVALS

- A. If any glycol is removed from the building's systems and is to be disposed of, the Contractor is responsible to remove the glycol from the site and have it properly disposed of with respect to EPA and all local guidelines. The contractor shall carry the cost of removal within his bid. Putting the product down a drain will not be acceptable.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Contractor is responsible for supplying the proper amount of the product to the heating and chilled water glycol systems, contractor to reference contract drawings for piping sizes and lengths to determine volume. Contractor is responsible for filling system to 40% concentration. A written report is to be completed as specified in Part 3 – Execution.
- B. All anti-freeze on this project is to be 100% virgin anti-freeze. Any anti-freeze that is recycled or partially recycled formula shall be rejected without review. The submittal must state that anti-freeze is 100% virgin. If anti-freeze has been installed and found to have recycled component it shall be removed and replaced with new 100% virgin at contractor's expense.

2.02 PROPYLENE GLYCOL, DOWFROST (PG)

- A. Dow Chemical Co. inhibited glycol based heat transfer fluid, 95.5% glycols and 4.5% inhibitors and water by weight. Capable of protection from freezing to -23°F @ 42% and -12°F @ 30% and boiling to 250°F. Fluid shall contain special corrosion inhibitors that passivate the surface of metals and buffer any acids that form from normal oxidation. Fluid shall have a low acute oral toxicity.

2.03 ANTIFREEZE TESTER

- A. Model #YA845, Snap-On-Tools Corp.; or equal. Contains six temperature compensating discs to show degree of protection thru a magnified tube. Shall have a scale range of 25°F to overprotection. Also includes flexible rubber hose.

2.04 INJECTION TANKS (IT-1)

- A. Chemical Feed system for glycol solution. Each system to include one 50 gallon polyethylene tank with hinged cover and one feed pump with 1/2 HP motor mounted below tank. Motor to be 115V/1Ph. Pump suction of PVC tubing to include ball valve and strainer. Pump discharge of schedule 80 PVC pipe includes ball valve and check valve. Additional accessories to include: PVC float switch, pressure switch, relief valve, pressure gauge on discharge and NEMA 12, 115V control panel. Controls to include a 24 volt control circuit, H-O-A for pump, low tank level indicator and pump "on" indicator.

PART 3 - EXECUTION

3.01 GENERAL

- A. Fill system 100% with water. Hydrostatically test the system to check for any leaks.
- B. Remove all air from the system as per filling instructions. See Section 232113 - Piping Systems & Accessories.
- C. Partially drain system to accommodate the appropriate quantity of glycol.
- D. Disposal of anti-freeze: all fluid removed from fluid cooler which contains anti-freeze solution shall be pumped into temporary tankage and disposed of offsite in an approved manner. Do not drain fluids containing anti-freeze on the ground or directly into building floor drains
- E. Add the appropriate amount of glycol fluid to the system and circulate for 24 hours to insure complete mixing.
- F. Test concentration of solution using tester specified and add any necessary amount of glycol to reach the desired level.
- G. Provide written report to Architect stating volume of antifreeze solution added, concentration level of antifreeze and expected freeze point of solution.

END OF SECTION 23 2510

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section.

1.02 SUBMITTALS

- A. Schedule of all components.
- B. Product data sheets on all equipment.
- C. Submit shop drawings on all equipment. Include all performance and dimensional data.

1.03 GENERAL REQUIREMENTS

- A. All control dampers shall have published performance data taken from test made in accordance with AMCA Standard 500 and in compliance with the AMCA certified ratings program for air performance and air leakage performance.
- B. All fire dampers shall be rated for 1-1/2 hrs (unless specifically noted otherwise) under UL Standard 555 and shall meet NFPA 90A construction requirements.
- C. Backdraft dampers shall have performance data published under the guidelines of AMCA and conform to all safety standards as set forth by NFPA 90A.

PART 2 - PRODUCTS

2.01 VOLUME DAMPERS

- A. Provide where indicated on drawings or required to control air flow, for air balancing, size as required, manually operated.
- B. For Rectangular Ducts up to 12" Max Dimension: Single blade volume damper for use by air balancing contractor. Damper may be fabricated by sheetmetal contractor. Damper blade shall be fabricated from stiff material and be free from operating noise. Ensure sufficient clearance between damper blade and duct wall to prevent noise. Provide external position indication and locking quadrant.
- C. For Rectangular Ducts Over 12": Furnish and install where indicated on drawings, size as required, manually operated, opposed blade damper, 16 ga. galvanized steel construction, concealed linkage, with manual locking quadrant. Model #VCD-20, Greenheck Fan Corporation; or equal.
- D. For Round Ducts: When volume damper is not an integral part of branch connection, furnish and install where indicated, size as required, manually operated, round air balancing damper, galvanized steel construction with manual locking quadrant. Model VCDR-53, Greenheck Fan Corporation.
- E. BD-1: Backdraft damper, nonmetallic type with blades constructed of neoprene coated fiberglass. Extruded aluminum channel. Model #BD51, Pottorff Mfg.; or an approved equal. Don't have a vinyl blade damper.

- F. BD-2: Counter balanced backdraft damper, constructed of 75 aluminum blades with neoprene blade seal and steel axles will ride on ball bearing. Model #EM-30, Greenheck Fan Corporation.
- G. OBVD-1: Opposed Blade Volume Damper, aluminum construction, parallel blade, Oilite Bronze bearings, Stainless steel jamb seals and vinyl blade seals, stainless steel linkage. Model #VCD-43, Greenheck Fan Corporation.

2.02 REMOTE CONTROL DAMPER REGULATORS

- A. RC-1: Concealed damper regulator, ceiling installation, embedded in the finished ceiling so unit is flushed with finished surface. Cover plate shall be 2-5/8". Finish shall be cadmium. Ceiling remote controller shall be Young Regulator Co., #301-HRS-3/8" with coupling; or equal. Furnish OBD control damper, Model #820A-C for operation from ceiling regulator, as manufactured by Young Regulator Company.
- B. RC-2: Round Duct: Furnish remote control circular damper, #850, as manufactured by Young Regulator Co.; or an approved equal. Furnish corner pulleys, union connectors, compression fittings and brass tubing, quantity as required. Furnish remote operator, #700-SM.
 - 1. Rectangular Duct: Furnish remote control OBD, extruded aluminum construction, Model #830A, as manufactured by Young Regulator Company; or an approved equal. Furnish with corner pulleys, compression fittings, union connectors, brass tubing and cable all as required for complete and proper installation. Furnish operator Model #700-SM, for surface mounting, Type "C" indicator dial, as manufactured by Young Regulator Company; or an approved equal.

2.03 FIRE DAMPERS

- A. FRD-A: Fire dampers used in transfer air sleeves between adjacent rooms above ceilings, UL listed 1-1/2 hour rating. Nailor Industries Model #0110 or equal.
- B. FRD-B: Fire dampers shall be manufactured, tested and labeled in accordance with UL 555 Safety Standard for Fire Dampers - Sixth Edition, June 1999, and shall have 1-1/2 hour fire resistance rating. Each fire damper shall bear a UL label verifying fire resistance rating in addition to intended mounting position. Fire dampers shall be suitably constructed for vertical or horizontal installation as required for each specific location. Each fire damper shall be complete with a 165°F (74°C) UL Listed fusible link. Fire dampers shall each include a steel sleeve of appropriate length/gauge and retaining angles, supplied by damper manufacturer to ensure proper installation in accordance with damper manufacturer's instructions. Damper to have blades out of air stream. Contractor shall provide and install an access door at each fire damper, of appropriate size to allow for inspection, testing and fusible link replacement. Information submitted for approval shall include confirmation of UL qualifications, pressure drop data and manufacturer's installation instructions. Fire dampers shall be Nailor Industries Models 0120 (Type B), or equal. Use Model 0130V or 0130H for round ducts.
- C. FRD-S: Provide fire/smoke dampers where indicated on drawings. UL 555S classified Class II leakage rating at 250 degrees and UL 555 listed 1-1/2 hour labeled. Nailor Model # 1270ERL with min. 16" long 20 gauge sleeve and 120 volt electric actuator, with actuator out of airstream, and 165°F heat responsive device. Contractor shall provide and install an access door at each fire damper, of appropriate size to allow for inspection and testing. Electrical contractor shall furnish smoke detector to heating contractor – heating contractor to install within 5'-0" of damper. Install detector per manufacturer's recommendations and requirements.

2.04 DUCT ACCESS DOORS

- A. Furnish and install where indicated on plans and/or required for access to life safety dampers, control probes, etc.; galvanized door with manual lock(s), double wall, 1" internal fiberglass insulation, galvanized steel frame, foam gasket seal, minimum 24 gauge construction. Label each access door at fire dampers with "Fire Damper" in letters no less than 1/2" high.
1. Hinged Type: Model #H-10, Buckley Air Products
 2. Double Latch Type: Model #C-10, Buckley Air Products

2.05 ARCHITECTURAL ACCESS DOORS

- A. Ceiling/Wall Access Door: door and frame for use in existing ceiling or walls. Door and frame fabricated from galvanized steel, thickness as scheduled, with rounded edges and concealed pivoting rod hinge. Frame shall be one piece construction with no miters or welds exposed on face. Door shall include screw driver type latch mechanism.
- B. For Existing Ceilings: Provide concealed 1-1/2"x 1-1/2" support angles to be used as a sub-structure to support door frame above existing ceiling.
- C. For Fire Rated Doors: Doors shall be UL Listed for fire rated service as scheduled. Door shall include heavy duty spring closer.

Tag	AD	ADF
Model #	BNTC 24x24	BIT 24x24
Manufacturer	Babcock-Davis	
Fire Rating (hours)	None	1.5
Fire Rating Label	None	B
Steel Thickness	16 gauge	16 gauge
Size (inches)	24x24	24x24
Weight (lbs)	16	24.5
Latches (Qty)	3	1
Notes	(1)(2)	(1)(2)

Notes:

- (1) Finish factory prime coat, contractor shall field paint white to match ceiling where located.
- (2) Contractor shall verify actual size prior to ordering if required to fit actual ceiling tile arrangement, size may be adjusted to 22x22. However, no gaps are to be allowed from door frame flange and adjacent existing ceiling tiles around perimeter.

2.06 CODE REQUIREMENTS

- A. All work shall be in accordance with all applicable codes including NFPA 90A, 90B, and SMACNA requirements.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install all equipment in strict accordance with manufacturer's instructions.

3.02 DAMPERS

- A. Contractor to furnish all required hardware to complete installation of air split damper and regulator.
- B. Provide access doors for dampers not accessible from grilles.
- C. Dampers shall be installed so as not to cause stress or strain on the frames. Fasteners shall not interfere with proper operation of blades or linkages.
- D. Lubricate and thoroughly clean all moving parts according to the manufacturer's recommendations before initial operation.
- E. Seal all seams.
- F. Make all necessary adjustments to linkages to insure dampers open fully and close tightly over full stroke of actuator.
- G. Replace any damaged parts including blades, seals, linkages, etc.
- H. Install automatic vent damper in strict accordance with manufacturer's instructions and NFPA 54.

END OF SECTION 23 3300

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications Sections apply to work of this section.

1.02 SUBMITTALS

- A. See Section 233330 for submittal requirements.

1.03 WORK INCLUDED

- A. Contractor shall provide all hangers and supports for all ductwork and air system equipment and accessories.
- B. Contractor shall field verify and coordinate all ductwork hangers and supports, dimensions, clearances, and ductwork elevations with new and existing building structure.

1.04 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 233330 - Low Velocity Ductwork
- B. Section 230713 - Duct Insulation

1.05 QUALITY ASSURANCE

- A. SMACNA Manual: Methods of supporting ductwork shall be in accordance with the SMACNA Manual, Section 1 - Low Velocity Systems", unless otherwise shown on the drawings or specified herein.
- B. SMACNA - Sheetmetal and Air Conditioning Contractors National Association, Inc.
- C. Electrically operated and power actuated tools for installing welded studs and power driven fasteners shall be listed by a nationally recognized test agency.

PART 2 - PRODUCTS

2.01 DUCT HANGERS

- A. All Hangers Shall Be Rod Type Hangers: Mild carbon steel, unless otherwise specified; fully threaded or threaded each end, with (2) removable nuts each end for positioning and locking rod in place. Unless galvanized or cadmium plated, provide a shop coat of red lead or zinc chromate primer paint.
- B. Hangers for ducts shall be as specified in the SMACNA Manual, with the following exceptions:
 - 1. Lower hanger attachments for rectangular duct with any dimension 18" and above shall be trapeze hangers, supported by threaded rods (3/8" dia. min.).
 - 2. Trapeze hangers shall be minimum 1-1/2" x 1-1/2" x 1/4" angle or larger size as required by larger or heavier ductwork. Ductmate trapeze hanger size AS and AT is acceptable.

3. Lower hanger attachments for rectangular duct with maximum dimension less than 18" may be flat strap attached directly to duct. Fasteners penetrating ducts must be completely sealed.
4. Wire used as supports or as banding shall not be acceptable.
5. Fasteners used on hanger system shall not penetrate supported ductwork. (Exception: Flat strap hangers, see above.)
6. Threaded support rods shall utilize sufficient support, jamb, and lock nuts to allow adjustment of duct heights.

2.02 MISCELLANEOUS FASTENERS AND UPPER HANGER ATTACHMENTS

- A. Machine Bolts and Nuts: Galvanized or cadmium plated steel.
- B. Steel "C" Clamp with Locknut: Elcen Co.; No. 29L, with 25B steel retaining clips.
- C. Structural Aluminum Shapes and Aluminum Plates.
- D. Structural Steel Shapes and Steel Plates: ASTM A-36, shop primed.
- E. Self Drilling Expanding Fasteners: Phillips type.

2.03 BRANCH FITTINGS, JOINTS & TURNING VANES

- A. Provide supports necessary for lengths over 16" or heights over 8".

PART 3 - EXECUTION

3.01 UPPER HANGER ATTACHMENTS

- A. General Notes: Upper hanger attachments for ductwork shall be secured to overhead structural steel or steel bar joists wherever possible, unless otherwise specified.
- B. In addition, when required by ductwork support spacing schedules, provide intermediate structural steel members, framed to span the structural steel or steel bar joists. The minimum size of structural steel members, for use as intermediate steel framing, shall be 2-1/2" x 2-1/2" x 1/4" steel angles. Intermediate steel members shall be shop prime coated prior to installation. Intermediate steel will be sized for span and load to show no deflection.
- C. Secure upper hanger attachments to bar joists at the panel points of joists.
- D. Do not drill holes in main structural steel members.
- E. Exercise extreme care in the field drilling of holes in precast or pre-stressed concrete work, so as to avoid damage to reinforcing. Power driven types of fastening devices shall have be utilized in the attachment of hangers to precast or pre-stressed concrete work.

- F. Upper hanger attachments shall be as specified in the Manual, with the following exceptions:
1. Do not use flat bar, bent rod, power actuated drive pins or expansion nails as upper hanger attachments in concrete construction.
- G. Attachment to Structural Steel: Secure to steel beams with beam clamps, welded studs, power actuated fasteners, or "C" clamps with lock nuts and minimum 1/8"x1" wide safety bars.
- H. Do not use power actuated fasteners except by written permission from the Engineer's Representative.
- I. Do not attach welded studs or powder actuated fasteners to steel less than 3/16" in thickness.
- J. Do not use power drive on beam clamps.
- K. Attachment to New Poured Concrete Construction: Support hangers from concrete insets. Properly locate and install concrete inserts in concrete form work as required, in ample time so as not to delay the construction work. Bolt band iron hangers to inserts with 3/8" bolts. Screw rods into proper size inserts and secure with lock nuts and washers.
- L. Attachment to Cellular Steel or Fluted Metal Decks: Do not support ductwork from cellular steel or fluted metal roof decks. Attach hangers to structural steel members wherever possible, and where required intermediate structural steel supporting members shall be provided, framed to span the structural steel.
- M. For attachment to overhead cellular steel or fluted metal decking, other than roof decks, hangers may be attached by means of welded studs with double nuts. The maximum load on any one stud shall be 250 lbs. **UNDER NO CIRCUMSTANCES SHALL UPPER ATTACHMENTS PENETRATE STEEL DECKING, OR ROOF DECK.**
- N. Riser Supports: Support vertical rectangular ducts by means of two steel angles or channels, anchor bolted to floor slab or adjacent structural member at every floor through which the riser passes. Steel angles or channels shall contact a transverse joint and be secured to the joints by means of 1/8" bolts, or by welding.
- O. Steel angle or channel support sizes shall be as follows:

Max. Side Dimension	Support Angle	Support Channel	Bear on Concrete or Structural Support
36"	1"x1"x1/8"	1"x1/2"x1/8"	2"
48"	1-1/2"x1-1/2"x1/8"	1-1/2"x3/4"x1/8"	3"
60"	2"x2"x1/8"	2"x1"x1/8"	3"
Over 60"	2-1/2"x2-1/2"x3/16"	2"x1"x3/16"	4"

3.02 DUCT HANGER SPACING

- A. The duct hanging method must be in accordance with this specification and is subject to Engineer's approval.
- B. Duct hanger spacing shall be in strict accordance with SMACNA and as follows:
1. Rectangular Duct Hangers Min. Sizes:

<u>Max. Half of Duct Perimeter</u>	<u>Rod Pair at 10' Spacing</u>	<u>Rod Pair at 8' Spacing</u>	<u>Rod Pair at 6' Spacing</u>	<u>Rod Pair at 4' Spacing</u>
Up to 72	1/4"	1/4"	1/4"	1/4"
73 to 96	3/8"	1/4"	1/4"	1/4"
97 to 120	3/8"	3/8"	1/4"	1/4"
121 to 168	1/2"	3/8"	3/8"	3/8"
169 to 192	1/2"	1/2"	3/8"	3/8"
Above	SEE SMACNA FOR SPECIAL CONDITIONS			

2. Round Duct Hanger Strap Sizes:

<u>Duct Diameter</u>	<u>Strap Hangers</u>	<u>Max. Spacing</u>
Up to 26"	One 1" x 22 Ga.	12 Ft.
27" - 36"	One 1" x 18 Ga.	12 Ft.
37" - 50"	One 1" x 16 Ga.	12 Ft.
51" - 60"	Two 1" x 18 Ga.	12 Ft.

See SMACNA, Table 5-3 for allowable loading for trapeze angles.

END OF SECTION 23 3310

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to work of this section.

1.02 SUBMITTAL

- A. Layouts of duct systems shown on contract drawings are diagrammatic. Actual duct layout and fabrication shop drawings are required to be submitted for approval. Coordinate these shop drawings with other trades and existing conditions, as required for proper installation, prior to submittal.
- B. Please note that ductwork CAD files will not be given to the contractor. Contractor is expected to field verify and draw all ductwork.
- C. General duct layout, 3/8" = 1'-0" scale, of all duct systems, including dimensions and elevations.
- D. Ductwork shop drawings shall be fabrication drawings, showing actual intended location of ductwork and clearances. Ductwork elevations and architect's ceiling heights shall be noted on drawings.
- E. All areas where ductwork is below the architect's ceiling height shall be noted and clouded. **FAILURE TO NOTE BOTH BOTTOM OF DUCT ELEVATIONS AND ARCHITECT'S CEILING HEIGHTS WILL BE CAUSE FOR REJECTION.**
- F. Duct shop drawings shall show actual existing and/or new structural steel arrangements, and shall be coordinated to properly fit in intended spaces.
- G. Sheetmetal contractor shall verify that ductwork layouts are coordinated with all other construction trades which might cause a conflict. This contractor is required to provide copies of duct shop drawings to all applicable contractors for their use in coordination efforts.
- H. Immediately notify Engineer if a duct layout conflict is discovered.
- I. Submittal packages which do not include all items listed in this section will be considered incomplete and will be returned to the contractor without review.
- J. If a significant number of shop drawings are required, individual drawings may be submitted for review. Duct construction booklet must accompany initial submittal or it will be considered incomplete and returned without review.
- K. Fabrication of installation of ductwork shall not be permitted unless duct shop drawings and construction booklet are approved by Engineer.
- L. Contractor will be required to remove ductwork installed without duct submittals conforming to requirements of this section and approved by the Engineer.

1.03 DUCT CONSTRUCTION BOOKLET

- A. Duct construction booklet shall be submitted with initial duct layout drawing submittal.

B. The following is a basic list of materials, devices, methods, etc. that shall be described in the ductwork construction booklet submittal:

1. Manufacturer's data sheets for all purchased duct accessory components (damper hardware, duct liner, access doors, etc.)
2. Gauges of ductwork, material, method of construction, types of reinforcing and joints, etc.
3. Transverse and Longitudinal Joints
4. Duct Fitting Construction
5. Duct Sealing & Sealants
6. Duct Hangers, Type, Spacing, Upper, Lower
7. Special Supply Air Duct Construction Details (i.e. 14 gauge)
8. Branch Duct Connections Details
9. Acoustic Lining
10. Flexible Ductwork
11. Flexible Connection (to AHU's etc.)
12. Access Doors
13. Duct Accessories
14. Volume Dampers
15. Locking Quadrants
16. Remote Control Damper Regulators
17. Turning Vanes
18. Penetration Trim Frames
19. Fire Damper Installation Details
20. Fire Proofing Penetrations, Chase Safing
21. Specialty Duct Construction and Installation Methods
22. Other Specialty Equipment Connections

1.04 RELATED SUBMITTALS

A. The following shop drawings are required under other specification sections and must be submitted as separate packages (in addition to ductwork submittals detailed in this section).

1. Exhaust Fans
2. Louvers
3. Roof Hoods
4. Diffusers, Registers, Grilles
5. Ductwork Accessories:
 - a) Special volume control dampers
 - b) Fire and/or smoke dampers
 - c) Remote control damper actuators

1.05 WORK REQUIRED

- A. Contractor shall furnish materials and labor and shall fabricate and erect all sheetmetal ductwork including connections to units, all dampers, registers, diffusers and accessories as shown on the drawings, described herein and/or as required to make the air handling installations complete.
- B. Complete supply and return air ductwork serving all units.
- C. All exhaust air ductwork.
- D. Relief air ductwork.
- E. Ductwork and connection into existing air systems where applicable in existing building.
- F. Installation of all intakes and discharges including exhaust fans, louvers, roof hoods.
- G. Specialty ductwork and specialty equipment for applicable kitchen, fume exhaust, safety hoods, and other specialty systems where indicated.
- H. Modification of existing air system equipment to meet new air system requirements (i.e. - fan drives, belts, sheaves, fan motors, etc.).
- I. Complete balancing of all air systems.
- J. Contractor shall field verify and coordinate all ductwork, dimensions, clearances, and ductwork elevations with existing building structure.

1.06 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230005 - MECHANICAL Work General
- B. Section 230593 - Testing, Adjusting & Balancing
- C. Section 230713 - Ductwork Insulation
- D. Section 233300 - Ductwork Accessories
- E. Section 233310 - Ductwork Hangers & Supports

1.07 QUALITY ASSURANCE

- A. SMACNA Manual: Gauges of materials, fabrication and installation of ductwork shall be in accordance with the SMACNA Manual, Section 1 - "Low Velocity Systems", unless otherwise shown on the drawings or specified herein.

- B. SMACNA - Sheetmetal and Air Conditioning Contractors National Association, Inc.
- C. New York State Energy Code.
- D. 2016 New York State Building Code.
- E. Electrically operated and power actuated tools for installing welded studs and power driven fasteners shall be listed by a nationally recognized test agency.

1.08 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect materials of this Section before, during and after installation and to protect installed work and materials of all other trades.
- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.
- C. Delivery and storage: Deliver all materials to the jobsite in their original unopened containers with all labels intact and legible at time of use. Store in strict accordance with the manufacturer's recommendations.
- D. Ductwork that is shop fabricated shall be delivered to the site in quantities acceptable to the storage area that the General Contractor has available.

PART 2 - PRODUCTS

2.01 GENERAL

- A. For the purpose of establishing equality, certain manufacturers have been specified herein. In no way shall this be construed as limiting competition. Products of other manufacturer's may be proposed in accordance with the provisions of the Contract.
- B. Fabrication: All ducts, unless otherwise allowed, shall be true to dimensions indicated upon plans, straight and smooth on inside, with neatly finished joints. Securely anchor to building construction in acceptable manner, free from vibration under all conditions of operation, and properly brace and reinforce with aluminum angle or other structural members. Slip joints shall be in direction of flow. Elbows shall have centerline radius equal to 1-1/2 times width of duct.
- C. **NOTE: ALL DUCTWORK SERVING A VAV SYSTEM SHALL BE RATED FOR 3 IN. W.G. STATIC (POSITIVE OR NEGATIVE) AND SHALL CONFORM TO SMACNA. ALL OTHER DUCTWORK SHALL BE RATED FOR 2 IN. W.G. STATIC (POSITIVE OR NEGATIVE).**
- D. All ductwork with a 4 to 1 ratio, and higher shall have a Condu-lock internal reinforcing at midpoint between joints, both horizontally and vertically.
- E. All ductwork 10 ft downstream of a VAV to be internally lined, whether shown or not.

2.02 SHEETMETAL

- A. Galvanized Steel: ASTM A653/A653M lock forming quality – zinc-coated (galvanized): ASTM A653/A653M commercial coating class – 0.9 oz. per sq. ft.

- B. 2" W.G. Low Pressure Rectangular Duct Construction:
1. Note: These gauges are 1 gauge heavier than required by SMACNA.

<u>Longest Side</u>	<u>Gauge</u>	<u>SMACNA Rigid Class (1)</u>	<u>Stiffeners Spacing</u>
0-12"	24	A	5'
13-30"	22	B	5'
31-54"	20	B	5'
55-84"	18	E	5'

- C. 2" W.G. Low Pressure Round Duct Construction:

<u>Diameter</u>	<u>Gauge</u>
0-12"	26
13-24"	24
25-36"	22

- D. Aluminum Ductwork: Use 1 gauge heavier than required by SMACNA Standards.

2.03 LONGITUDINAL JOINTS FOR RECTANGULAR DUCT

- A. Seams shall be formed and assembled with proper dimensions for tight and secure fit. Notching shall be minimal consistent with transverse joint requirements.
- B. Standard longitudinal seam shall be Pittsburgh Lock. Standing seams are not acceptable.

2.04 TRANSVERSE JOINTS FOR RECTANGULAR DUCT

- A. Joint type shall be selected on the basis of $\pm 2"$ wg. Pressure class, materials, support intervals, and other provisions for proper assembly of ductwork.
- B. All transverse joints with any dimension greater than 16" shall be constructed with the Duct Mate system; or an approved equal. All transverse joints 16" and less shall be slip and drive.
- C. Contractor shall submit for approval the intended joint type with the duct construction detail book submittal.
- D. Turning Vanes and Vane Runners: Weld runners to duct and weld vanes to runners, all as shown on the drawings. All turning vanes shall be air foil type.

2.05 DUCTWORK FITTINGS

- A. All elbows on main supply ducts shall be radiused type fittings.
- B. Where square elbows are allowed, turning vanes shall be used. Square fittings without turning vanes are not permitted.

2.06 BRANCH CONNECTIONS

- A. Furnish and install where indicated on drawings, size as required, the following:
 1. For rectangular branch ducts: 45 degree cinch collar, each branch duct to include a volume damper.

2. For round duct branches: High efficiency take-off type fitting with integral volume damper.
3. Branch duct connections regardless of size or type will be fully sealed by an approved method.

2.07 ROUND DUCT CONSTRUCTION

- A. Round duct seams shall be spiral lockseam type. Snap lock or lap seams are not acceptable. Duct and fittings shall be single wall Uni-Seal Duct, United McGill Corp.; or equal, unless noted otherwise.

2.08 FLAT OVAL

- A. Duct shall be of a spiral lock seam construction with a mechanically formed seam locking indentation evenly spaced along the spiral seam. All spiral duct 8" diameter and larger shall incorporate multiple corrugations between spiral seams. Duct shall be galvanized steel that conforms to ASTM standards A653 and A924 and be in accordance with SMACNA 2005 Duct Construction Standards and shall conform to SMACNA's MECHANICAL Duct Construction Standards for +10" water gauge pressure. Connection methods shall be slip-fit with all joints being sealed by the installer during the installation process. The type of sealant used as well as the method and level of application should be in accordance with the sealant manufacturer's published installation instructions and as specified hereinafter. All fittings that are either spot-welded or button punched construction are internally sealed. All transitions and divided flow fittings which convert from flat-oval to round 60" diameter or less. Provide 1" lining where indicated on drawing.

2.09 DUCT SEALING REQUIREMENTS

- A. All ductwork, fittings, connections to equipment, damper connections, branch duct connections, and other duct system joints shall be sealed in accordance with the duct system sealing schedule.
- B. The term sealed requires the use of liquids, mastics, combination mastics and open weave fabric, gaskets, or other sealing compounds made exclusively for duct work applications. Oil base caulking and glazing compounds shall not be used.
- C. Tapes shall not be applied to metal surfaces or to dry sealant.
- D. Liquid: As recommended by the manufacturer of the ductwork.
- E. Mastic: 3M Co. #ED-800 or 900.
- F. Gaskets: Soft neoprene or reinforced inert plastic of the self conforming type.
- G. Special Note: All sealants must be applied in ambient temperatures exceeding manufacturer's recommendations to insure proper setup.
- H. Seal all penetrations with Manville Pyro-Fiber safing; or equal. Provide safing clips and joint sealant.

2.10 DUCT SYSTEM SEALING SCHEDULE

- A. Supply, Return & Exhaust Ductwork: Completely seal all transverse joints and longitudinal seams.
- B. Connection to Equipment: Use flanged connections to equipment, provide gasket to seal between flanges. Bent sheetmetal is not acceptable as a flange. Use steel angle or heavy gauge flat bar as a back up surface.

2.11 DUCT LINER

- A. Furnish and install where indicated on drawings, acoustic duct liner.
- B. Duct liner shall: made from flame attenuated glass fibers bonded with a thermosetting resin, air stream side to be coated with a non abrasive black surface. Furnish 2" thick, permacoat Linacoustic manufactured by Johns Manville; or equal. Duct liner rated for use at 250°F, 5000 fpm, with a k-factor of 0.25 and acoustical performance NRC of 0.70.
- C. Ductwork having internal lining is not to be externally insulated, unless otherwise noted.
- D. Any lined duct that has had water on the liner, shall be deemed unusable and will be required to be immediately removed from the site. The contractor shall provide an new section at no cost to the owner.
- E. Note: Duct sizes shown are net inside duct dimensions, not including internal liner. Failure to comply with this requirement will be grounds for rejection.

2.12 FLEXIBLE DUCTWORK

- A. Furnish and install where indicated on drawings, bi-directional reinforced metallized vapor barrier with triple ply stand-up seam; acoustically rated black CPE liner permanently bonded to a coated spring steel wire helix and supporting a thick blanket of fiberglass insulation. UL listed, Class 1 air duct. Flexible Tubing Division, Thermaflex, Type MKE; or equal. For connections to rectangular duct, use Bellmouth fittings with integral volume damper. Flex duct is not to be connected directly to rectangular main ducts. Duct centerline radius to duct diameter ratio not to exceed 1.5. Flex duct to have minimum R-value of 6.0.
- B. Maximum length of flexible ductwork not to exceed 8'-0".

2.13 EQUIPMENT CONNECTIONS

- A. All equipment shall be connected to ductwork with flexible duct collars.
- B. Flexible connection shall be heavy glass fabric, coated with "Durolon", weighing approximately 24 oz. per sq. yard, as manufactured by Duro Dyne Corp.
 - 1. For ducts 30" and below use 3" free length
 - 2. For ducts above 30" use 5" free length.

2.14 TRIM FRAMES

- A. Whenever ductwork passes through masonry, furnish and install mitered angle trim frames around ductwork to conceal rough masonry opening.

2.15 EXTERIOR DUCTWORK

- A. If there is any exterior ductwork to be installed on the project, there shall be a mandatory meeting with the MC, the sheetmetal subcontractor, insulation subcontractor, the owner's representative and the engineering field representative prior to any duct being fabricated.
- B. The MC shall produce a detail of how they will install the ductwork with respect to attachment to the

duct supports, detail of how the duct shall penetrate a wall or roof and installation of insulation and external weather wrap.

- C. All exterior ductwork shall be pressure tested prior to insulation being installed \ to a minimum of 2 in wg. A report shall be given to the owner's representative and the engineer stating that the duct had been tested, any leaks have been sealed and the duct retested to ensure no leakage.
- D. All exterior ductwork over 18" shall be a minimum of 18 gauge, with a ductmate connection every 5 ft. All ductwork over 24" shall have condu-lock-internal reinforcing at every joint and at midpoint between joints. Exterior supports shall be a minimum of every 8 ft.
- E. All exterior ductwork transverse connections shall be ductmate connection. TDF will not be acceptable on the exterior of the building. All longitudinal seams will be sealed.
- F. There shall be no breaks in the external wrap on the ductwork. If there are any openings that need to be made (balancing, equipment, etc) the MC is fully responsible for sealing the opening immediately. If rain goes on the ductwork prior to the wrap being sealed, the MC shall be fully responsible to remove all wrap and insulation to the owner's representative and engineering field representative's satisfaction that there is no water on the insulation and provide new insulation and new external wrap per specifications.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Properly seam, brace, stiffen, support and render ducts mechanically air tight. Where SMACNA plates and/or the specifications indicate duct stiffeners or reinforcing angles, they shall be continuous around all four sides and interlock at corners.
- B. Adjust ducts to suit local conditions, and if necessary to accomplish this, dimensions may be changed, as approved, but maintain cross sectional area. Install ductwork so as to provide maximum headroom, unless otherwise noted on the drawings.
- C. In addition to having all shop joints in ductwork fabricated in accordance with the Manual, all field joints shall be sealed air tight in accordance with the duct seal schedule.
- D. Where turning vanes, balancing damper or any other kind of products are installed, ductwork must be reinforced at all four sides and interlocked at corners.

3.02 FLEXIBLE DUCTWORK CONNECTIONS

- A. Flexible connections shall be made with tie straps as made by Panduit; or equal. Straps shall be used to clamp both inner and outer liner to diffuser and branch ductwork. (2) straps are required at each end of flexible ductwork.

3.03 CONNECTIONS TO MISCELLANEOUS DUCT EQUIPMENT

- A. All duct connections to duct coils, etc. must be made with smooth transitions in accordance with SMACNA. Duct dimensions specified upstream and downstream (net free area) must be maintained. Sizing ductwork to match miscellaneous equipment is not acceptable, unless design conditions are met.

END OF SECTION 23 3330

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1 Specification Sections apply to the work of this section.

1.02 SUBMITTALS

- A. See Section 233330 for submittal requirements.
- B. In addition to plan layouts, provide vertical sections describing all vertical grease duct runs.
- C. Shop drawings shall indicate allowance for fire proof insulation.
- D. Construction booklet shall include all special construction methods for grease duct.
- E. Detail all grease duct special access doors and openings.

1.03 WORK INCLUDED

- A. Definition: For the purposes of this specification, ductwork serving cooking hood exhaust shall also be known as grease duct.
- B. Furnish materials, labor to fabricate and erect sheetmetal ductwork and all accessories specified in this section.
 - 1. Complete cooking hood exhaust air ductwork system.
 - 2. Connection to kitchen hood & exhaust fan.
 - 3. Access door assemblies. Access doors shall be located at each floor penetration and at each change of direction.

1.04 RELATED WORK

- A. Work in this section shall be in accordance with applicable provisions in section 233330 - Low Velocity Ductwork.
 - 1. Section 233310 - Ductwork Hangers and Supports
 - 2. Section 233813 - Kitchen Exhaust Hoods
 - 3. Section 230713 - Ductwork Insulation

1.05 CODE REQUIREMENTS

- A. All work shall be in accordance with all applicable codes including NFPA 90A, 90B, and SMACNA requirements.
- B. All ductwork covered under this section shall be in strict accordance with NFPA 96 (standard for "Installation of equipment for removal of smoke and grease laden vapors from commercial cooking equipment").

PART 2 - PRODUCTS

2.01 DUCTS SERVING TYPE I HOODS (GREASE AND SMOKE)

- A. Kitchen hood ducts shall be black carbon steel minimum thickness No. 16 MSG (0.054").

- B. All seams, joints and penetrations shall have a liquid tight continuous external weld.
- C. No internal projections or obstructions of any kind will be allowed in grease ductwork.
- D. Use of bolted or flanged type connections are not permitted. The outer surface of the grease ducts shall be smooth with no flanges or other projections (exception: external weld bead).
- E. Use of fasteners which penetrate the duct wall or project into the duct are not permitted.
- F. Duct systems shall be continuous and liquid tight with no penetrations except access doors.
- G. All fittings shall be radiused type ELLS; no mitered elbows, turning vanes, or joints are permitted.
- H. Connections to equipment shall be by an approved method and shall be liquid tight.
- I. Ductwork accessories shall be listed for this application.
- J. All grease ducts shall be hung with trapeze hangers.
- K. Contractor Option: Supply listed prefabricated grease ductwork. A pre-engineered UL listed for grease duct system is acceptable as a substitution.
- L. Access Doors:
 - 1. Factory-fabricated, -listed, and -labeled, double-wall access doors tested according to UL 1978 and rated for 500 deg F continuously, or 2000 deg F for 30 minutes; with positive or negative duct pressure and complying with NFPA 211.
 - 2. Construction: 0.0625 inch ASTM A666, Type 304 stainless-steel inner shell and aluminized-steel outer cover with two handles.
 - 3. Fasteners: Stainless-steel bolts and wing nuts.
 - 4. Access Door Dimensions: 18 x 12 inches or as shown on drawings and required to fit duct.
 - 5. Door Label: Mark door with uppercase lettering as follows: "ACCESS PANEL. DO NOT OBSTRUCT."

2.02 DUCTS SERVING TYPE II HOODS (HEAT AND STEAM)

- A. Ducts shall be Type 304, stainless-steel sheet, No. 2D finish
- B. All longitudinal seams shall be welded.
- C. All transverse joints shall either be welded or flanged with watertight EPDM gaskets.
- D. All ductwork shall be hung with trapeze hangers.
- E. No internal projections, obstructions, or fasteners of any kind will be allowed ductwork.
- F. Duct systems shall be continuous and liquid tight with no penetrations except access doors.
- G. All fittings shall be radiused type ELLS; no mitered elbows, turning vanes or joints are permitted.
- H. Connections to equipment shall be by an approved method and shall be liquid tight.

PART 3 - EXECUTION

3.01 DUCTS SERVING TYPE I HOODS (GREASE AND SMOKE)

- A. Install all ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- B. All joints shall be welded and shall be telescoping, bell, or flange joint as per NFPA 96.
- C. Ductwork shall be sized to maintain a minimum air velocity of not less than 1500 FPM (unless shown on drawings sized for higher velocity).
- D. Dampers and auxiliary equipment shall not be installed in grease ducts unless listed for use in this application.
- E. Access doors shall be provided at each change in direction and at each floor penetration.
- F. For access doors, weld 3/8" studs to 3" deep extension frame, studs shall be spaced 4" O/C. Fully welded door shall be formed to fit into extension frame to allow a flush inner surface. Provide 1500°F high temperature gasket for each door. Weld flat stock handle to project through insulation on each plate. Ensure fasteners do not penetrate interior of duct space.
- G. Access doors shall not be located on the bottom side of ductwork, unless specifically allowed by the Engineer. Openings for access doors shall be cut into the side of ducts approximately 2" minimum above bottom surface to prevent possible leakage.
- H. Testing: Prior to the use or concealment of any portion of grease ductwork, a leakage test shall be performed by passing a light over the entire section of ductwork to be tested per section 506.3.2.5 of the Mechanical Code.

3.02 DUCTS SERVING TYPE II HOODS (HEAT AND STEAM)

- A. Install dishwasher exhaust ducts and other exhaust ducts from wet, high-humidity locations without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to dishwasher or toward drain.
- B. Provide a drain pocket at each low point and at the base of each riser with a 1-inch trapped copper drain from each drain pocket to open site floor drain.
- C. Minimize number of transverse seams.
- D. Do not locate longitudinal seams on bottom of duct.

END OF SECTION 23 3351

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary conditions and Division 1 Specification Sections, apply to work in this section.

1.02 SUBMITTALS

- A. Schedule of exhaust fans and all accessories.
- B. Sound power ratings.
- C. Product data sheets for all equipment.
- D. Dimensioned shop drawings.
- E. Special Note: Fans sizes may be selected for future capacities. Fan size substitutions which do not meet intended future capacities will not be accepted.
- F. Provide submittal indicating maximum, minimum and design RPM for fan size.

1.03 GENERAL REQUIREMENTS

- A. Provide supply, and exhaust fans to fit intended use and location as indicated on plans and/or specified.
- B. Capacity, size and arrangement, static pressure, brake horsepower, component parts and accessories as scheduled and/or as necessary to obtain required results and allow for proper maintenance. Motor efficiency shall comply with EISA standards.
- C. Ratings based on tests made in strict accordance with current AMCA sound and performance standards including standard #210.
- D. Each size fan to be supplied shall be tested in the manufacturer's laboratory under simulated installation **CONDITIONS**. Ratings based on test, not on interpolated or extrapolated calculation.
- E. Submit certified performance tests by AMCA for all centrifugal fans 5,000 CFM and larger.
- F. Guaranteed full capacity delivery through duct systems finally installed and under conditions listed.
- G. Guaranteed sound-power level ratings not exceeding those of design equipment.
- H. All equipment statically and dynamically balanced to acceptable tolerances with all weights permanently fastened.
- I. When dampers are supplied, furnish all necessary relays and devices to permit operation.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL FANS DESCRIPTION

- A. Centrifugal fan belt driven (unless otherwise noted). Fabricated from formed and curved material with continuously welded seams. Provide removable covers or access doors to allow access to internal parts. Drive frame structure constructed of heavy gauge galvanized steel.
- B. Drive assembly and wheel shall be removable without disassembly of fan housing. Fan shaft shall be painted to avoid corrosion. Furnish accessory hinging kit to facilitate access to fan internal components and ductwork.

2.02 MOTORS

- A. All motors shall be general purpose squirrel-cage induction type, NEMA Design 8, Class 8 insulation, continuous duty, 40°C ambient, single or multiple speed as scheduled, designed for 60 hertz operation.
- B. All three phase motors shall be NEMA Premium Efficiency design. Motor efficiency shall be indicated on the motor nameplate by the manufacturer per IEEE Standard 112 Method 8 in accordance with following tables:

Open Drip Proof (ODP)

Horsepower	1200 RPM	1800 RPM	3600RPM
1	82.5%	85.5%	77.0%
1.5	86.5%	86.5%	84.0%
2	87.5%	86.5%	85.5%
3	88.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	90.2%	91.0%	88.5%
10	91.7%	91.7%	89.5%
15	91.7%	93.0%	90.2%
20	92.4%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.6%	94.1%	91.7%

Totally Enclosed Fan-Cooled (TEFC)

Horsepower	1200 RPM	1800 RPM	3600 RPM
1	82.5%	85.5%	77.0%
1.5	87.5%	86.5%	84.0%
2	88.5%	86.5%	85.5%
3	89.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	91.0%	91.7%	98.5%
10	91.0%	91.7%	90.2%
15	91.7%	92.4%	91.0%
20	91.7%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.0%	93.6%	91.7%

- C. Single speed motors shall operate at 1750 RPM unless otherwise indicated.

D. For All Motors with Motor Starters:

1. Provide premium efficiency motor.
2. Fractional HP motors shall be equipped with internal automatic reset thermal overload switch.
3. Provide factory mounted and wired safety disconnect switch; locate in motor compartment. When disconnect will not fit in motor compartment furnish weatherproof NEMA 3R safety switch for external mounting.

E. Motors for Units With Variable Frequency Drives:

1. Motor shall be rated for inverter duty.
2. Provide motor of continuous duty, 1.15 SF, NEMA Class F insulation
3. For fractional horse motors with variable frequency applications provide permanently split capacitor or shaded pole type motor.
4. See Specification Section 238505 - Variable Frequency Drive Systems for further details.

F. ECM Motors

1. Motor to be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable.
2. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase.
3. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor.
4. Motor shall be speed controllable down to 20% of full speed (80% turndown).
5. Provide fan with the following fan speed control device (unless otherwise noted):
 - a) Constant Speed Operation: Fan speed potentiometer, factory mounted and wired, for fan operation at a constant volume. Potentiometer shall be utilized for balancing.
 - b) Variable Speed Operation: When scheduled with multiple airflows, a fan speed controller capable of accepting a 0-10 VDC signal from BMS, and any required transformer for powering controller to allow for variable speed operation throughout the range indicated. Contractor shall be responsible for any field wiring of components if they do not come factory mounted and wired.
6. Motor shall be a minimum of 85% efficient at all speeds.

2.03 FAN DRIVE ASSEMBLIES

- A. Fan manufacturer shall furnish motors, V-belts and drives complete and ready to operate. Drives shall include the following:
1. Drives rated at 150% of motor horsepower.

2. Motors 5 HP and larger: Minimum of two belts.
 3. Use only matched belt sets for multiple drives.
 4. Cast iron or cast steel pulleys.
 5. Provide test holes in belt guards for speed checks.
 6. Provide shaft guards where shafts extend beyond belt guards.
 7. Adjustable type motor pulley with 15% speed adjustment above and below rated speed.
 8. Drive ratio not over 4:1 except as otherwise approved.
- B. For Variable Frequency Applications:
1. Do not use belt drives
 2. All variable frequency applications shall utilize direct drive fans.

2.04 FAN BEARINGS

- A. Fan manufacturer shall furnish all fans with self-aligning, grease lubricated, ball or spherical roller bearings selected in accordance with rating method of Anti-Friction Bearing Manufacturers' Association, so "rating life" is not less than 50,000 "life hours" continuous operation at maximum speed and pressure for each AMCA fan class. If requested by Engineers, submit bearing selection calculations for approval.

2.05 VIBRATION ISOLATION

- A. Fan manufacturer to furnish vibration isolation equipment for each piece of equipment supplied.

2.06 KITCHEN FANS

- A. Equipment shall meet latest edition of NFPA Article 96 (Requirements for commercial cooking equipment).
- B. Kitchen fans shall be similar to standard exhaust fans with the following additional requirements:
1. Fan(s) shall be upblast vertical discharge type.
 2. Motor and drives isolated from air stream with insulated barrier.
 3. Oversized air tube for motor cooling located away from fan discharge.
 4. Grease trough with drain connection to baffled grease trap container.
 5. Vented curb extension to meet 40" minimum discharge height above roof surface.
 6. Weatherproof NEMA 3R disconnect switch mount on curb extension (wiring connections in liquid tight flexible conduit by EC).
 7. Hinging kit to allow fan to be opened to facilitate access to ductwork.
 8. Fans must be UL/cUL 762 listed.

2.07 ROOF CURBS

- A. Furnish prefabricated welded galvanized steel roof curb for all roof fans. Roof curb with rigid fiberglass insulation and wood nailer held in place by metal wrap-around. Standard height to be 12"

above finished roof unless otherwise noted. Roof curbs will be fully assembled and placed onto the roof by the MC for installation by GC.

- B. Bottoms of curbs to sit level on roof. Contractor is to verify any roof pitches prior to submittal. Provide pressure treated wood blocking to raise roof curb base to top of finished roof surface.
- C. Roof curb to include metal liner to protect insulation (NO EXCEPTIONS!).
- D. Cant strips formed into curb body. Provide raised cant for use with insulated roof decks. For fans located on rubber roof membranes raised cant is not to be supplied with curb.
- E. For units with dampers furnished by fan manufacturer provide damper shelf mounted inside of curb. Alert duct sub-contractor to this condition for proper damper and duct installation.

2.08 UTILITY SET

A. Description:

- 1. Factory-fabricated, -assembled, -tested, and -finished, centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure. Fan shall be belt or direct driven per equipment schedule.

B. Housings:

- 1. Housing Material: Reinforced steel., treated with a high performance powder coating, unless otherwise noted.
- 2. Formed panels to make curved-scroll housings with shaped cutoff.
- 3. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
- 4. Discharge Arrangement: Fan scroll housing field rotatable to any multiple discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

C. Wheels:

- 1. Wheel Configuration: SWSI, with hub keyed to shaft, statically and dynamically balanced.
- 2. Wheel and Blade Materials: Steel unless otherwise noted to attain a spark resistant construction rating per equipment schedule.

D. Shafts:

- 1. Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed.

E. Required Accessories:

- 1. Companion Flanges: Rolled flanges for duct connections of same material as housing.

2. When motorized dampers are not indicated, provide backdraft dampers of gravity actuated type with counterweight and interlocking aluminum blades, with felt edges in steel frame installed on fan discharge.
 3. Belt Guard: OSHA-compliant, completely enclosed shaft and drive components.
 4. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 5. Equipment Rails with housed vibration isolators – isolators shall be appropriate for mounting type and location.
- F. Additional required accessories when roof mounted:
1. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
 2. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
 3. Roof Equipment Support Rails: This contractor shall furnish prefabricated 18 gauge welded galvanized steel rail with integral base plate. Size to be 12" larger than unit that it supports or a minimum of 8" overhang each end over joist (whichever dimension is larger). This contractor shall verify actual length dimensions required. This Contractor shall provide pressure treated top rail/wood blocking and metal cap flashing of sufficient width and length to cover insulation. Insulation, flashing, roof membrane, cap flashing and sealants shall be installed on rail by General Contractor. Rail to be Model ER-2B; RPS Corporation.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install equipment in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements.
- B. Field services shall be provided by a factory trained representative to fully set-up and adjust the new units, after the installations have been completed and before the units are placed in service. Written start-up report to be furnished. Factory alignment, mechanical seals, lubrication, three phase motor rotation, and all necessary commissioning tests shall be completed and checked before units are placed in service.
- C. Install vibration isolators in strict accordance with manufacturer's instructions.
- D. Provide all necessary supporting ironwork for equipment requiring same.
- E. Provide guards for all exposed belts, shafts or fan wheels.
- F. Change pulley sizes as many times as necessary, as part of contract, to make systems deliver specified quantities of air.
- G. Roof curb must be roofed and flashed to the top of wooden nailer to assure weather tightness.
- H. Bolt fan housing to curb.

- I. Install vibration isolation per manufacturer's requirements. Bolt, provide hold down tabs over bottom isolator plate, or lag to equipment rail, floor, support steel, or other mounting location to ensure a stable, secure installation of equipment.

END OF SECTION 23 3416

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

- A. Schedule indicating drawing no., room location, quantity, size, throw, direction of throw, accessories, finish, material type, color chart, etc.
- B. Product data sheet for each unit indicating throw, noise criteria ratings, directional data (four-way, etc.) material, accessories, mounting details, etc.
- C. Noise criteria shall conform with specified equipment performance data.
- D. If requested by Engineer, provide sample of diffuser, register, grille, etc.

1.03 GENERAL REQUIREMENTS

- A. Duct drawings are diagrammatic and do not provide exact locations for diffusers, registers and grilles. Contractor shall reference reflected ceiling plans or instructions by Architect for a more exact location of diffusers, etc., with respect to ceiling grid, light fixture and sprinkler etc.
- B. Each manufacturer shall check noise level ratings for their equipment to insure that the sizes selected will not produce noise to exceed 30 db, "A" scale, measured at occupant level; notify Engineer of any problems in this regard and change equipment size accordingly.

1.04 REQUIREMENTS FOR DIFFUSERS, REGISTERS AND GRILLES

- A. All units and accessories shall be installed "sight-proof" where possible.
- B. Borders and frames shall be of same material and color as specified for grille face.
- C. Total quantity of air equally divided, or as required and/or shown, where diffusers blow in more than one direction. Provide blank off plate (finished to match unit) to match blow pattern shown on drawings.
- D. Each supply register and diffuser shall be guaranteed to deliver indicated capacity and proper throw with draftless diffusion, and within acceptable noise level.
- E. Limit terminal velocity at walls of room, below 25 fpm, measured 4' above floor.
- F. Contractor shall provide proper duct connection to all diffusers, registers and grilles. Ductwork connections shall be as required by unit manufacturer. Connections required by Contractor include but are not limited to square/round adapter, transitions, flanges, neck rings, etc.
- G. Because of intricate system designs and special performances required, all devices may not be of same make.
- H. Suitable for recessed mounted unless otherwise indicated.

- I. Diffusers and registers that are scheduled with integral opposed blade volume damper at neck must match unit construction and must be able to be adjusted through face, without removing unit.
- J. Diffusers, registers and grilles do not require volume control dampers unless specifically indicated.
- K. All exposed fasteners must be tamper proof.
- L. Security Grille Face: Where indicated, provide heavy duty security type, tamper proof, secure grille face. Grille shall be 12 ga. thick cold rolled steel 1/2" sq. perforated grille. Fasteners shall be located 6" C/C around perimeter. Unit shall have white prime finish suitable for field painting. Provide A.J. Manufacturing Co.; or equal.

PART 2 - PRODUCTS

2.01 GENERAL

- A. See drawings for schedule.

2.02 TRANSFER GRILLE ASSEMBLY

- A. TG-1: Furnish and install where indicated on drawings, TG-1 assembly consisting of: (2) grilles, (1) fire damper and (1) duct sleeve. Each grille shall include plaster frame. Fire damper shall be 1-1/2hr, Air Balance Model #119AF; or equal. Locate as shown. Paint all visible interior surfaces flat black. Do not paint fire damper.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All equipment specified under this section shall be installed where called for on plans and in compliance with the contract documents.
- B. Install equipment in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements.
- C. Diffusers in lay-in type ceiling tiles shall be located at center of tile, squared with tile edges.

END OF SECTION 23 3713

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section.

1.02 SUBMITTALS

- A. Submit shop drawings on all equipment specified. Operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL PROVISIONS

- A. Furnish and install a complete kitchen exhaust hood and system components as manufactured by Econovent Systems, Inc. The exhaust system is to be the compensating type, using un-tempered filtered outside air introduced into the hood front.
- B. Exhaust double wall canopy shall be constructed of 16 ga. polished No. 304 stainless steel with No.4 finish; both the exterior shell and interior liner. Exterior shell shall be liquid tight, continuously welded, with all visible welds ground smooth and blended, conforming to the latest edition of NFPA Bulletin No. 96. Exhaust canopy shall bear the NSF No. 1113 label, BOCA label per research report 78-46, and UL label listing fusible link fire damper at the exhaust collar.
- C. The supply air chamber shall have a fully insulated interior with 1", 3 lb. density aluminum skin vapor barrier insulation. Insulation shall be fastened to the chamber walls with a cured mastic tape. Below each supply air inlet opening, a perforated metal air diffuser plate shall be installed to ensure an even air distribution.
- D. The exhaust canopy shall include UL listed 115V vaporproof incandescent lights. All lights shall be factory mounted and wired in conduit to a power junction box, for field connection to the power supply. Light bulbs are not included.
- E. Exhaust canopy shall include 2" deep UL listed aluminum panel extractors or mesh grease filters. Filter removal tool shall be included.
- F. The kitchen exhaust fans shall be as manufactured by Jenn-Air, upblast configuration for use in kitchen grease exhaust systems. Fan(s) must include all aluminum construction and internal service disconnect switch.
- G. Supply air fans shall be Econovent Systems. All air must pass thru metal mesh air filters mounted before the centrifugal fan wheel. Fan(s) must include internal service disconnect switch.
- H. All roof curbs are to be provided by the fan supplier and shall conform to local codes. Curb construction shall be aluminum with a 2"x2" wood nailer around the full perimeter of the curb inside diameter. All exhaust canopies include an opposed blade balancing damper for field installation at each canopy's supply air damper.

- I. A control panel is provided by the kitchen exhaust system supplier to interface with and control the exhaust system operation. This panel shall include fan motor starters and fuses, light interlocks, and pilot lights to indicate supply fan or exhaust fan operation.
- J. All supply air and exhaust air openings are to be on the centerline of the canopy and these openings must be factory cut with duct collar.
- K. Fire Suppression System: All hoods shall be served by a single fire suppression system located on the KEH-1 hood as shown on drawings. The system shall automatically: protect the exhaust ducts, hood, and cooking appliances and shut off the main fuel supply to the appliances by means of a mechanically activated gas line shut off valve. The valve shall have resilient seating with an aluminum body and stainless steel internal parts. In addition, the valve shall have an external indicator of the closed or open position. The system shall be furnished with manual pull stations where shown on drawings. The system enclosure shall be an integral part of the exhaust hood and shall match the hood finish. The enclosure shall also provide enough room to house the electrical control panel serving the hood. The enclosure access door shall be custom made to accommodate the ceiling recess of 4". The system shall be Ansul #R-102; or equal.
- L. Skirting: Provide closure panel (height as scheduled) to run vertically from top of hood to ceiling height. Panels shall be removable for service.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. This installing contractor shall guarantee all materials and workmanship for one (1) full year from the date of system acceptance by Owner.
- B. All exhaust ductwork from the exhaust canopy to the exhaust fan shall be 16 ga. welded black iron, liquid tight, and shall conform to the latest NFPA Bulletin 96, and to all local codes regarding elbows, traps, access doors and insulation. All ductwork from the un-tempered supply air fan to the exhaust canopy shall conform to current SMACNA standards and the latest edition of NFPA Bulletin 96. The exterior of this ductwork shall be fully insulated and wrapped, per local codes.
- C. Provide 16 gauge enclosure from top of canopy to finished ceiling to match hood finish. Install in removable sections to enable access for dampers and maintenance.
- D. Check, Test & Balance: Kitchen exhaust system shall be inspected, tested and balanced by an Econovent Systems, Inc. factory representative to ensure proper and satisfactory operation. Econovent Systems, Inc. must provide a written and detailed report of this check, test and start-up service to the specifying engineer and owner.
- E. The fire protection system shall be installed by a factory authorized contractor.
- F. This contractor shall provide training for the Owner's personnel in the operation of the system, and service for a period of (1) year.

END OF SECTION 23 3813

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

- A. Submit shop drawings of units with all accessories as specified in this section. Shop drawings shall include schedule of units including ratings of fan and coils. Sound power levels shall be submitted. Submit (3) copies of installation, operation and maintenance manuals.
- B. Submittals shall be marked to show specified information.

1.03 GENERAL REQUIREMENTS

- A. Provide outdoor, roof curb mounted, packaged air conditioning units to fit intended use and location as indicated on Plans and/or specified:
- B. Capacity, size and arrangement, static pressure, brake horsepower, component parts and accessories as scheduled and/or as necessary to obtain required results and allow for proper maintenance. Ratings based on Standard Test Code for Centrifugal Fans, adopted jointly AMCA and ASHRAE. Each size fan to be supplied shall be tested in the manufacturer's laboratory under simulated installation conditions. Ratings based on test, not on interpolated or extrapolated calculation. Guaranteed full capacity delivery through duct systems finally installed and under conditions listed. Guaranteed sound-power level ratings not exceeding those of design equipment. All equipment statically and dynamically balanced to acceptable tolerances with all weights permanently fastened. Fan bearings shall be rated for 200,000 hour life continuous operation at maximum speed and pressure in accordance with ANSI Code B3.15.
- C. Equipment shall include motors, belt drives, belts, and required accessories; horsepower as scheduled. Motor efficiency shall comply with EISA standards.
- D. Equipment manufacturer shall furnish vibration isolators for each piece of unit as required; spring type or unit fully internally isolated with thrust restraint springs, flexible connections and deflection springs.

PART 2 - PRODUCTS

2.01 PRODUCT DESCRIPTION

- A. Roof Curb:
 - 1. Where scheduled furnish prefabricated, 12 ga. galvanized roof curb height above insulation 12": to be supplied by unit manufacturer.

B. Unit Casing:

1. Unit shall be furnished with insulated discharge plenum.
2. Unit shall be completely insulated with 2" thick neoprene coated glass fiber secured to side, top and end panels with adhesive and mechanical fasteners. Lifting brackets with lifting holes shall be provided on the unit base to accept cable or chain hooks.
3. Filters shall be 2" thick, removable throwaway filters.
4. Where roof curb scheduled; unit frame and base shall be 14 ga. galvanized steel. Unit to have formed recess that seats on roof curb gasket to provide watertight seal.
5. Where roof curb not required provide weatherproof sheet metal bottom pan with full thickness insulation.

C. Supply Fan:

1. Supply fan shall be centrifugal, forward curve, statically and dynamically balanced for quiet operation. Fan motor shall be heavy duty, open drip proof with re-lubricative ball bearings.
2. Furnish fan assembly with vibration isolated floating frame.

D. Gas Heat Section:

1. Unit shall include indirect fired separated combustion heating furnace with heat exchange (material as scheduled) including induced draft blower, electric pressure switch to lock out gas valve. Furnish gas ignition system with electronic ignition, modulating (see schedule) gas valve and safety system.

E. Heating Coil Sections:

1. Steam coils non freeze type (IDT) shall have aluminum fins helically wound to 518" OD copper tubes. Steam shall be distributed into each tube by an inner distributing perforated tube. Tube shall be brazed to steel headers with NPT connections. Working pressure 175 psig at 400°F.
2. Hot water heating coils shall be aluminum plate fins with belled collars bonded to 1/2" minimum OD copper tubes by mechanical expansion. Galvanized steel casings and steel headers with threaded connections. WP 300 psig, at 200°F. Coils shall be drainable, no turbulence promoting devices, headers shall have drain and vent connections.

F. Compressor:

1. Shall be heavy duty, scroll type, semi-hermetic type with reversible, positive displacement oil pump, and overload protection. Each compressor shall have a complete refrigeration circuit including, sightglass, filter drier, manual shutoff valve and relief valve. Compressor shall be mounted on vibration isolation blocks.

G. Cooling System:

1. Cooling Coil shall be seamless copper tubing, mechanically bonded to corrugated aluminum fins. Coils shall be factory leak tested. Furnish with factory mounted expansion valves. Cooling coils shall be circuited for combination row/face split.
2. Drain Pan with a mastic coating shall be provided with the cooling coil and extend beyond the leaving side of the coil and underneath the cooling coil connections. The drain pan shall be connected to a threaded drain connection extended through the unit base. Units shall be provided with a secondary mastic coated drain pan connected to the primary drain pan.
3. Furnished cooling system complete with refrigeration controls. Where scheduled furnish optional unloading steps complete with suction switches and step controller. The refrigeration controls shall include expansion valve, safety hi/low pressure switches and anti cycling timer.

H. Relief Type:

1. Gravity relief system (where scheduled) shall include exhaust air damper 0-100% rated SA located in the return air section to relieve air out the back of the unit. Exhaust dampers shall be sealed with urethane gasketing on the contact edge. Exhaust louvers and bird screen shall be provided.
2. Powered relief (where scheduled) shall include powered relief exhaust air fan, sized for 100% relief, with a relief air damper. Fan shall be controlled with an integral VFD factory wired speed controller.

I. Heat Recovery System:

1. Heat wheel (where scheduled) unit shall include an ARI rated heat wheel system, factory mounted and wired .
2. Wheel shall be a total energy (sensible) type unit with a cleanable, lightweight polymer material with a bonded desiccant coating. Unit shall be equipped with upstream disposable 4" pleated OA filters.
3. Wheel drive motor and controls shall be factory mounted and wired.

J. Electrical Power Requirements:

1. Weatherproof safety disconnect switch with external lever shall be provided by unit manufacturer.
2. Unit shall be equipped with a single point connection. All internal motors sub feeds shall have individual overcurrent protection housed in an electrical enclosure which shall include terminal blocks for all field connections.
3. All motors shall include integral motor starter or variable frequency drive as indicated and shall be factory mounted and wired.

K. Controls: Controls by Temperature Control Contractor. See Specification Sections 230993 and 230994 for details.

2.02 MOTORS

- A. All motors shall be general purpose squirrel-cage induction type, NEMA Design 8, Class 8 insulation, continuous duty, 40°C ambient, single or multiple speed as scheduled.
- B. All three phase motors shall be NEMA Premium Efficiency design. Motor efficiency shall be indicated on the motor nameplate by the manufacturer per IEEE Standard 112 Method 8 in accordance with following tables:

Open Drip Proof (ODP)

Horsepower	1200 RPM	1800 RPM	3600RPM
1	82.5%	85.5%	77.0%
1.5	86.5%	86.5%	84.0%
2	87.5%	86.5%	85.5%
3	88.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	90.2%	91.0%	88.5%
10	91.7%	91.7%	89.5%
15	91.7%	93.0%	90.2%
20	92.4%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.6%	94.1%	91.7%

Totally Enclosed Fan-Cooled (TEFC)

Horsepower	1200 RPM	1800 RPM	3600 RPM
1	82.5%	85.5%	77.0%
1.5	87.5%	86.5%	84.0%
2	88.5%	86.5%	85.5%
3	89.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	91.0%	91.7%	98.5%
10	91.0%	91.7%	90.2%
15	91.7%	92.4%	91.0%
20	91.7%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.0%	93.6%	91.7%

- C. Single speed motors shall operate at 1750 RPM unless otherwise indicated.
- D. Motors controlled by Variable Frequency Drive (VFD) units shall be rated for inverter duty (NEMA MG1, Part 31).

PART 3 -EXECUTION

3.01 GENERAL

- A. Install in strict accordance with manufacturer's instructions.
- B. Duct connection to units shall have flexible connections.
- C. Furnish (1) spare set of filters for each unit.
- D. This Contractor is responsible to furnish and install condensate trap and drain external to unit; drain shall discharge to roof.

E. Roof curbs to be fully assembled and placed onto roof by HC, for installation GC.

END OF SECTION 23 7500

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.02 ALLOWANCES, ALTERNATES, AND UNIT PRICES

- A. Refer to Division 1 specifications for allowances, alternates and unit prices required as part of this Contract.

1.03 INTENT

- A. The intent of the drawings and these specifications is to provide all systems complete and operative. Whether indicated on the drawings and/or included in the specification or not, provide all materials, equipment and labor usually furnished with such systems.

1.04 DEFINITIONS

As Called for	Materials, equipment including the execution specified/shown in the contract documents.
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Design Make	Indicates minimum requirements for equipment.
ERL	Existing to be relocated. (see definition of relocate).
EXR	Existing to remain. Make connections to maintain circuit.
Exposed	Work not identified as concealed.
Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
Furnished by Others	Receive delivery at job site or where called for and install.
Inspection	Visual observations by Owner's site Representative.
Install	Mount or set equipment, device or fixture and make electric connections.
Labeled	Refers to classification by a standards agency.
Make Provide	Refer to the article, BASIS OF DESIGN. Furnish and install complete.

Relocate	Disassemble, disconnect, store and transport equipment to new locations, then clean, test, and install ready for use.
Replace	Remove and provide new item.
Review	A general contractual conformance check of specified products.
Roughing	Pipe, duct, conduit, equipment layout and installation.
Satisfactory	As specified in contract documents.
Site Representative	Construction Manager or Owner's Inspector at the work site.

Refer to General Conditions of the Contract for additional definitions.

1.05 WORK INCLUDED

- A. In general, the electrical work includes, but is not necessarily limited to the following:
 - 1. Provide Removal Work and all temporary electric and communications connections to maintain services during construction.
 - 2. Provide Grounding of services, raceway systems, disconnects and devices, etc.
 - 3. Provide Interior lighting, wiring, conduits and switching.
 - 4. Provide Power and convenience outlet branch circuits, devices, etc.
 - 5. Provide Exit and emergency lighting.
 - 6. Provide power circuits and select controls to mechanical equipment.
 - 7. Provide modifications to existing Simplex Fire Alarm System.
 - 8. Provide Interior Horizontal Communications raceways and cable.
 - 9. Provide modifications to existing IP cameras at direction of owner's security contractor.
- B. Refer to Division 1 front end specifications for additional scope requirements and phasing.

1.06 BASIS OF DESIGN

- A. The contract documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Make required changes in the work of other trades, at no increase in any contract. Provide larger electrical feeders, circuit breakers, equipment, additional control devices and other miscellaneous equipment required for proper operation and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls ceilings or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.07 QUALITY ASSURANCE

- A. Manufactures of equipment shall be firms regularly engaged in the production of factory fabricated systems and equipment whose products have been in satisfactory use in similar service for not less than (3) years.
- B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided

1.08 LICENSING

- A. The contractor shall hold a license, issued, or recognized by the Authority Having Jurisdiction, to perform electrical work.

1.09 INSPECTIONS

- A. Provide rough in and final inspection by an electrical inspector certified by the AIAEI (the American International Association of Electrical Inspectors).

1.10 REMOVAL, DISPOSAL AND HAZARDOUS MATERIALS

- A. All removed electrical equipment shall be removed from the site and properly disposed of.
- B. All hazardous materials must be disposed of in compliance with ENCON and all other regulatory agencies.
- C. The Owner may wish to keep certain equipment, therefore, check with Owner before removals to determine what may be salvageable.

1.11 TEMPORARY SERVICES

- A. Contractor shall provide a complete temporary light and power service in accordance with requirements of specification section 260016 - Temporary Electric Power.
- B. Refer to Division 1 sections for additional requirements.

1.12 CONTINUITY OF UTILITY SERVICES

- A. It is of paramount importance that each utility service operates continuously and without interruption. Whenever this contractor plans to make changes or alterations to any existing utility service, such plans shall result in no or minimum service interruption or inconvenience to Owner. This contractor shall plan and schedule any change or alteration to an existing utility service with Architect and Owner. Such planning, timing, and/or scheduling shall be approved by both these parties.

1.13 CODES AND STANDARDS

- A. National Electrical Code: All work covered under these Contract Documents shall conform to the latest issue of the National Electrical Code.
- B. Standards: All equipment shall meet all the requirements of ANSI, NEMA, IES, and IEEE standards.
- C. Listing: All equipment and devices for which Underwriters' Laboratory has a listing service, shall be UL listed and bear the UL listing label.
- D. All materials and installation methods shall comply with the following:
 - I. 2020 New York State Building Code, including all applicable amendments supplements to the following:
 - a. 2020 International Building Code
 - b. 2020 International Existing Building Code
 - c. 2020 International Fire Code
 - d. 2020 International Plumbing Code
 - e. 2020 International Mechanical Code
 - f. 2020 International Fuel Gas Code
 - g. 2020 International Energy Conservation Code
 - 2. National Fire Protection Association (NFPA).
 - 3. New York State Department of Labor Rules and Regulations.
 - 4. The Americans with Disabilities Act.
 - 5. New York State Department of Health.
 - 6. Local Municipality/City Codes and Ordinances and the Authority Having Jurisdiction.
 - 7. Local Fire Department.
 - 8. Insurance Carrier.
 - 9. National Electrical Contractors Association (NECA)
 - 10. Occupational Safety and Health Administration. (OSHA).

1.14 SUBMITTALS & SUBMISSION REQUIREMENTS

- A. All submittals shall be in accordance with Division 1 requirements, the following requirements listed below, and also as indicated in each specification section. All submittals not complying with the listing above will be returned to the contractor without being reviewed. Rejection by Architect or Engineer of any items submitted shall require resubmittal of acceptable items.
1. Within (30) days after receiving signed contract or notice to proceed, submit to Architect for review complete descriptive dimensional data and ratings for equipment and materials proposed to be furnished and installed. Submit (8) copies of data unless otherwise specified by the architect.
 2. All materials submitted shall clearly state the job name and specification section(s) that it applies to.
 3. Any package containing more than one piece of equipment or material shall also contain a schedule clearly listing all items in submittal. Schedule page (s) shall also indicate project name and building name.
 4. All submittals must be clearly marked using nomenclature used in this specification for proper item identification, schedule of usages, model numbers, construction materials, performance, data, etc.
 5. Projects involving multiple buildings must have the submittals separated by building. Submittals in which buildings are combined will not be accepted. (Exception: When specifically approved by engineer, basic materials may be submitted once.)
 6. The Contractor shall insure that dimensions of equipment to be used conform to the space allocated for the equipment on the drawings.
 7. Submittals traced or copied from contract drawings are not acceptable and will be returned without review.
 8. In the event material and/or equipment is installed prior to obtaining approval of shop drawings, and in the sole opinion of the Owner's Agent, this material and/or equipment does not meet the specifications, the Contractor shall be liable for the removal and the replacement at no additional cost to the contract.
- B. Samples: When requested by Engineer, provide samples of both specified equipment and proposed substitutions for review by the Owner's Agent. Such equipment shall be delivered to a location designated, or erected at the job site as directed. When neither is physically possible, arrange for the Owner's Agent to visit an acceptable site where the proposed equipment can be inspected.
- C. Substitutions:
1. Submittals for equipment or materials other than as specified shall be accepted for review by the Owner's agent.
 2. Approval of substitute equipment shall be based on functional, physical and aesthetic compatibility to the equipment specified as determined by the Owner's agent and approved by the engineer.

3. Where substitute equipment is approved, the contractor shall be responsible for, and bear the cost of any necessary changes by his trade or other trades to make the system complete and operable.
4. Contractor is fully responsible for providing coordination between all trades affected by equipment substitution.
5. When requested, contractor shall submit layout drawings indicating new dimensions and arrangements of substituted equipment. Layout drawings shall indicate all revisions necessary for all services affected by substitution.

1.15 FIELD INSPECTION

- A. As there are various conditions at the site which do not show on the accompanying drawings, or which are at variance with the conditions indicated on the drawings, it is important that each bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.
- B. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.16 PERMITS, CERTIFICATES AND FEES

- A. This Contractor shall obtain and pay for permits, certificates, fees etc. listed below. Costs for permits, fees etc. shall be included in the base bid amount.
 1. All required applications and permits to begin work.
 2. Certificate of inspection including Third-Party Agency.
 3. Fees and charges shall be obtained directly from the respective authority having jurisdiction.

1.17 GUARANTEE

- A. Contractor shall guarantee all work furnished through this contract including work performed by subcontractors, for a period of (1) year (unless otherwise noted), from the date of final acceptance. Contractor agrees to repair or replace any defective work or materials at no additional cost to the Owner. Contractor shall also pay for any damage to other work resulting from repairs to defects. Contractor shall furnish written guarantees to the Owner's agent in accordance with the general conditions.

1.18 TESTING AND INSPECTION

- A. Inspections required for any ordinances, regulations, instructions, laws, rules, standards and practices that require any work to be inspected or tested shall be performed. Contractor shall give Owner, Architect and Engineer timely notice of readiness of work for inspection or testing and the date fixed for said inspection or testing.
- B. Third-Party Agency must inspect completed installation and present Owner with Certificate of Inspection showing approval.

- C. Required local or municipal inspection. Process and present Owner with certificate indicating approval of such governing bodies.
- D. Contractor shall submit a written report to Architect, copy to Engineer, on results of each inspection or test on system or equipment supplied. Report shall contain all pertinent information, recommendations, approvals, additional work required, etc.
- E. Contractor is responsible to check rotation on all three phase equipment prior to turning on equipment for temporary or permanent use.
- F. Panelboard, Circuit Breaker, Transformer and Fuse Tests:
 - 1. Energize all possible lighting and equipment loads for a period of not less than eight hours.
 - 2. Check all fuses and circuit breakers for faulty tripping and excessive heat.
 - 3. Tabulate phase current on all feeders.
 - 4. Tabulate voltages at each panelboard (phase to phase and phase to neutral).
 - 5. Reconnect branch circuits that vary over 5% between high and low current.
 - 6. Reconnect transformer taps as required to adjust for high or low voltages.
 - 7. All tabulation sheets shall be presented to the Architect for approval, make any corrections determined by the Architect.

1.19 RECORD DOCUMENTS

- A. When required by general conditions or other Division 1 Section this Contractor shall prepare and turn over to Owner's agent record as-built documents. As-built drawings will include actual equipment location layout, service connections, etc.
- B. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

1.20 PENETRATIONS THRU FIRE RATED CONSTRUCTION

- A. All penetrations for new work or left from removed work by this contract through rated construction shall be sealed fire safe by a UL listed approved method.
- B. All electrical penetrations through walls, floors, etc. shall be conduit sleeved.
- C. All conduit penetrations through fire rated partitions, walls, floors, etc. shall be installed as follows; penetration shall be oversized 1/2" to 3/4" maximum. This Contractor shall pack with fireproofing insulation, type FS cerablanket. Outside of penetrations shall be caulked and sealed with flame stop V, as manufactured by Flame Stop, Inc.; or an approved equal. Flame stop sealant shall be troweled smooth for finishing as required.

- D. Electric panels installed in one- or two-hour fire rated walls shall be wrapped in an approved endothermic mat rated to maintain the assembly.

1.21 CONFINED SPACES

- A. All work in pipe tunnels, mechanical pits, well manholes, etc. shall be performed by skilled tradesman and laborers with current certification for working in confined space. Contractor shall bear all costs to provide all safety equipment, ventilation, etc. as required by State and Federal Regulations and shall obtain all necessary permits for such work.
- B. Contractor shall submit copy of current certifications and photo I.D. of all tradesman and laborers who will be working in confined spaces on this project.

1.22 INTENT OF DRAWINGS

- A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, fixtures, panelboards, and wiring devices. Exact locations are subject to the approval of the Owner's Representative. The general run of electrical feeders, branch circuits, and conduits, indicated on the drawings, is not intended to be the exact routing. Circuit designations, in the form of "Home Runs" on branches, indicate the designation of the branch circuit, and the panelboard or interconnection box from which the branch circuit is served.
- B. Drawings show general design and arrangement. Verify exact location and elevations at the job location. Do not scale plans and diagrams.
- C. Drawings do not show all offsets, fittings, interferences, and elevation changes. Adjust installation of conduit, equipment location, etc. to accommodate work with the obstacles and interferences. Where a major and important rearrangement is necessary, report same to Architect for review. Obtain written approval for all major changes.
- D. Prior to roughing in any back boxes for power or communications devices, thoroughly examine the architectural elevations, enlarged plans and details. Also exam vendor drawings and manufacturer instructions for equipment furnished by others or as part of this contract. Install back boxes in locations and at heights as indicated on these documents. If the locations are not detailed, issue an RFI to the construction manager to obtain them. Boxes that are roughed in without detailed location and heights will re-located at no additional cost to the contract by the electrical contractor.
- E. Cooperate with all Contracts and Owners and determine the exact route of all raceway and location of all equipment.

1.23 COORDINATION DRAWINGS

- A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings at not less than 1/4" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings As Follows:

1. HVAC Contractor will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be CAD drawings of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.
 2. HVAC Contractor will provide prints and Cad drawings and submit the base plan to all major trades' Contractors.
 3. Electrical, Plumbing and Fire Protection Contractors will draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.
- B. Contractors who proceed without approved coordination drawings will be responsible at no additional cost to move, reroute or replace their work that is in conflict.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.
- B. The listing of a manufacturer as "acceptable" does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems conform to the Specifications.

2.02 ACCESS DOORS

- A. Steel Access Doors and Frames: Fabricate units of continuous welded steel construction, unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to existing ceiling support system. Furnish with manufacturer's factory applied prime paint and top coat of white enamel.
 1. Frames: Fabricate from 16-gage steel. Frames shall be compatible with the existing ceiling suspension system.
 2. Flush Panel Doors: Fabricate from not less than 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees.
- B. Locking Devices: Furnish flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed. Provide a minimum of (2) cam locks for any units over 324 sq. inches.
- C. Acceptable Manufacturers: Karp Associates, Inc.; Meadow Craft, Inc.; Milcor, Div.; Inryco, Inc.

2.03 U.L. LISTING

- A. Equipment shall bear the Underwriter's Laboratories (UL), or other approved agency listing label. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with the National Electric Code and listed by U.L.

2.04 FIRE STOPPING FOR POWER AND COMMUNICATION OUTLETS

- A. Provide fire rated moldable putty around all power and communication outlet boxes in resident rooms. The putty shall meet the following:
 - 1. Firestop tested up to 4 hours in accordance with ASTM E 814 and (UL 1479)
 - 2. Wall opening protective tested up to 2 hours in accordance with UL 263
 - 3. Pliable and conformable to mold easily into required shape
 - 4. Re-enterable/repairable
 - 5. Halogen-free and solvent-free
- B. Design Make: 3M™ Fire Barrier Moldable Putty Pads MPP+ 6.

2.05 FIRE STOPPING FOR OPENINGS IN RATED WALLS

- A. Provide Fire-stopping for Openings through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.
- B. Acceptable Manufacturers:
 - 1. Dow Corning Fire-Stop System Foams and Sealants.
 - 2. Nelson Electric Fire-Stop System Putty, CLK and WRP.
 - 3. Thomas & Betts - S-100 FS500/600.
 - 4. Carborundum Fyre Putty.
 - 5. Hilti Firestop Systems.
 - 6. 3M Interam Endothermic Mats

PART 3 - EXECUTION

3.01 ROUGHING

- A. Obtain approved roughing diagrams and exact locations of equipment for items furnished under other Divisions of the specifications. Do not rough in without approved drawing.
- B. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. DO NOT SCALE PLANS. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the owners' representative for approval before proceeding.
- C. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.

- D. Do not rough in outlets back-to-back in adjoining walls offset as required by field conditions and provide fire rated putty around boxes.
- E. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location of all equipment in finished areas, such as thermostat, fixture and switch mounting heights, and equipment mounting heights.
- F. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.
- G. Before roughing for equipment furnished by Owner or in other contracts, obtain from Architect and other Contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owners representative or other contractor for any "rough ins" that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the electrical contractor at no expense to the Owner.
- H. For equipment and connections provided in this contract, prepare roughing drawings as follows:
 - 1. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.
 - 2. New equipment: Obtain equipment roughing drawings and dimensions, then prepare rough-in drawings.
 - 3. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.
 - 4. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

3.02 CUTTING AND PATCHING

- A. Provide cutting and patching required by and for the installation of the electrical work.
- B. Patching of fire rated floors, walls, partitions, etc. shall be made using new materials equal to the fire rating of the existing.
- C. Should changes, omissions or errors in electrical work require cutting, patching or making alterations in any portion of new construction, such work will be performed by a qualified tradesman.
- D. Cutting and patching of roof surfaces and structures shall only be performed by a qualified contractor, as approved by the Architect. The contractor shall bear the cost of above mentioned cutting and patching. This contractor shall insure that existing roof warranties remain in force.
- E. This contractor shall furnish lintels, sized to accommodate structure above opening, where cutting and patching is to be performed on load bearing walls. Contractor shall obtain written approval for all lintels prior to installation.
- F. Cutting shall be done in a manner which will not adversely affect the strength of the building. Holes and openings shall be neatly cut so as to provide a finished appearance and shall be patched around the edge where required for a finished appearance. Provide temporary bracing, shoring, etc. as required.
- G. Patching shall be structurally sound and match the existing materials and finish of adjacent materials. Patching is required in finished areas, wherever existing work is removed, at the sides of openings, etc. Patching shall include repairs, painting, etc.
- H. At the completion of the work, all evidence of alteration will be as inconspicuous as possible.

3.03 OPENINGS, SLEEVES, AND CHASES

- A. Certain chases, openings, and shafts will be provided as shown as part of General Construction Plans and Specifications.
- B. Provide all other openings and sleeves for conduit etc. through floors, walls, partitions, ceilings, roofs, etc. for Division 26-E work.
- C. Assume responsibility for correct and final location and size of such openings; furnish templates if required. Correct improperly located and sized or omitted chases and openings as required. Plug all abandoned sleeves left as part of this Contract.

3.04 SEALING AND FIRESTOPPING

- A. Installation of Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be as follows:
 - 1. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for dry wall construction.
 - 2. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

3. The methods used shall incorporate qualities that permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.
 4. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.
 5. Where boxes are installed flush in a rated wall provide an approved endothermic wrap around the entire enclosure. Seal conduit penetrations with approved fire putty.
- B. Installation of Fire-stopping around junction boxes between resident rooms and in rated walls in other areas of the building.
1. Provide fire rated putty around all boxes in all boxes in rated walls other than in resident walls.
 2. Mold the putty to the box and the connector for a complete seal of all openings and knock outs in the box.
 3. The surface of the electrical box, or opening and any penetrating items must be cleaned (i.e. free of dust, grease, oil, loose materials, rust or other substances)
 4. Ensure that the surface of the substrates are not wet and are frost-free.
- C. All penetrations from abandoned or removal electrical work shall be sealed fire safe by this contract.

3.05 SUPPORTS

- A. Provide required supports for work of this Contract, including beams, angles, channel, hangers, rods, columns, plates, bases, braces, etc. to properly support all work.
- B. Provide steel angles, channels and other materials necessary for the proper support and erection of motor starters, distribution panelboards, large disconnect switches, pendant-mounted lighting fixtures, etc.
- C. Panelboards, cabinets, large pull boxes, cable support boxes and starters shall be secured to ceiling and floor slab and not supported from conduits. Small panelboards, etc., as approved by Owner's Representative, may be supported on walls. Racks for support of conduit and heavy electrical equipment shall be secured to building construction by substantial structural supports.
- D. Provide concrete bases for all floor mounted equipment. Provide 3,000 lb. concrete, chamfer edges, trowel finish, securely bond to floor by roughening slab and coating with cement grout. Bases 2" high; shape and size to accommodate equipment. Set anchor bolts in sleeves before pouring and after anchoring and leveling, fill equipment bases with grout.
- E. See Specification Section 260190 – Supporting Devices for additional requirements

3.06 CONCEALMENT

- A. Unless otherwise specifically indicated, all work shall be concealed above ceiling space, in wall space, below slabs in crawl spaces, and elsewhere throughout the building.

- B. In areas with no ceilings, install only after Architect reviews and comments on arrangement and appearance.

3.07 TEMPORARY LIGHT AND POWER

- A. Provide temporary electric system as called for in specification section 260016.

3.08 ROOF AND ROOF DECK CUTTING AND FLASHING

- A. All penetrations through roofing and decking shall be accomplished by the roofing manufacturer's Certified Roofing Contractor in order to maintain roof system warranty.

3.09 EQUIPMENT INSTALLATION

- A. All installations shall comply with the following requirements:
 - 1. Provide code required disconnects for all electrical equipment that is furnished or connected by the electrical contractor.
 - 2. Coordinate electrical systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.
 - 3. The architect shall control the placement of all wall and ceiling mounted electrical equipment and devices in all rooms except for mechanical and electrical equipment rooms. When drawing details are not available, consult with the Architects representative for actual location.
 - 4. Verify all dimensions with field measurements.
 - 5. Arrange for all chases, slots and openings in other building components that are not indicated on drawings, to allow for electrical installations.
 - 6. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 7. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.
 - 8. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.
 - 9. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.
 - 10. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

11. Set all equipment to accurate line and grade, level all equipment and align all equipment components.
 12. All tolerances in alignment and leveling, and the quality of workmanship for each stage of work shall be as required by the manufacturer and subject to approval by the owner's representative.
 13. All finished equipment surfaces damaged during construction shall be brought to "as new" condition by touch up or repainting. Any rust shall be removed and primed prior to repainting.
 14. Workmanship shall be as called for in the "Standard of Installation" published by the National Electrical Contractors Association (NECA).
 15. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.
 16. No electrical equipment shall be hidden or covered up prior to inspection by the owners' representative. All work that is determined to be unsatisfactory shall be corrected immediately.
 17. All electrical work shall be installed level and plumb, parallel and perpendicular to other building systems and components.
 18. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his approval. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.
 19. Install access panel or door where units are concealed behind finished surfaces.
- B. Provide complete power connections to all electrical equipment. Provide control connections to equipment where indicated on the drawings. Provide disconnect ahead of each piece of equipment. Ground all equipment in accordance with the latest version of the National Electrical Code.
- C. Provide all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required for proper equipment operation of Owner-Furnished Equipment and Equipment furnished by other contracts,
- D. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to roughing.
- E. This contractor shall coordinate scheduling and installation of work with other contractors, sub-contractors and other trades. The contractor is also required to coordinate all work with owner supplied materials, direct contracts, and normal building operations, if any.
- F. All finished work shall be neat and workmanlike. All work of a special nature shall be performed by skilled and qualified workmen who can present credentials showing experience in said trade. New systems shall be delivered to Owner complete in perfect working order, tested and balanced in full accordance with plans and specifications. Existing systems shall function in same manner as before this work was performed. Any malfunctions which arise in existing systems as a result of demolition or alteration of parts of such systems shall be corrected.

- G. Layout of equipment, accessories and electrical systems in plan is generally diagrammatic unless specifically dimensioned or detailed. Check project drawings and existing site conditions before installing work for interferences as governed by structural or other conditions. Owner reserves the right to make reasonable changes in location of equipment, accessories or electrical systems prior to "roughing-in" without involving additional expense. Exact dimensions shown upon plans will be subject to verification and confirmation of exact conditions at site at time of construction. "Plus or minus" dimensions are shown upon drawing as a guide only. Exact surrounding conditions are governed by final equipment selection and/or other like details.
- H. Furnish all new equipment and materials as described herein. Any material, operation, method or device mentioned, listed or noted within this specification, if not specifically mentioned as furnished or installed by others, shall be furnished and installed by this contractor.

3.11 REMOVAL OF BALLAST IN EXISTING LIGHT FIXTURE

- A. Assume ballasts contain PCB materials unless labeled otherwise, or test samples to show materials are not PCB; submit test report. Remove all ballasts from existing light fixtures indicated on contract documents. Dispose of all ballasts which do not have non-PCB labels in PCB containers, and pay all costs to have containers taken to EPA-approved incinerators and disposed of per all EPA regulations. Follow all EPA regulations for transporting containers and materials. If ballast has leaked in existing fixture, remove material deposited in fixture, and dispose of those materials as listed above. Provide Certificate of Disposal and all associated paperwork to Owner's Representative.

3.12 FIRE ALARM DETECTOR COVERS

- A. Electrical Contractor is responsible to provide dust covers on all detectors whether new or existing in any area of construction. This shall be done in any area of construction even if there is no electrical work being done in this area. Coordinate with all trades.

3.13 ROOF PENETRATIONS

- A. Electrical Contractor is to refer to Division 7 for warranty requirements on existing roofs prior to any roof penetrations made.

3.14 PAINTING

- A. This Contract Includes the following:
 - 1. Painting for all cut and patch work performed as part of Division 26 and 27 work
 - 2. Painting required for touch-up of surfaces damaged due to the installation of electrical work.
 - 3. Painting as required to repair finish of equipment furnished.
 - 4. Painting of all surface mounted raceways in finished areas.

3.15 CLEANING

- A. After all tests are made and installations completed satisfactorily:
- B. Thoroughly clean entire installation, both exposed surfaces and interiors.
- C. Remove all debris caused by work.
- D. Remove tools, surplus, materials, when work is finally accepted.

3.16 CONTINUITY OF SERVICES

- A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical and electrical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical/electrical facilities or services.

3.17 OPERATION AND MAINTENANCE MANUALS

- A. Provide Operation and Maintenance Manuals. For projects containing multiple buildings, (3) three manuals shall be submitted separately for each building. Include the following:
 - 1. Equipment wiring diagrams.
 - 2. Manufacturer's instructions.
 - 3. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions.
 - 4. Recommended maintenance procedures.
 - 5. Include name, address, and telephone number of supplier manufacturer.
 - 6. Representative and service agency for all major equipment items.
 - 7. Panel schedules in hard copy and word or excel format.
 - 8. Bind above items in a three-ring binder with name of project on the cover.
 - 9. Provide USB drive with all data in word, pdf, or excel format.
- B. Refer to specific specification electrical specification sections for additional requirements.
- C. Deliver to Owner's Representative before request for acceptance.

3.18 ASBESTOS RECOGNITION AND PRECAUTIONS

- A. The contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the owner's asbestos management plan. Prior to performing such work identify areas containing asbestos. Notify the Owner so that they may make arrangements for abatement and/or containment prior to work proceeding. The contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 sections for further requirements.
- B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

END OF SECTION 26 0010

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

- A. Interior demolition, removal and abandonment of interior electrical systems including fire alarm.
- B. Cleaning and repair of existing equipment to remain.
- C. Construction managers Front end and Phasing documents for the description of work.
- D. 260016 - Temporary Electric Power
- E. 283111 - Addressable Fire Detection and Alarm
- F. Division 01 and 02 Specification sections.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching work: As specified in individual sections.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to beginning work inspect and test all existing electrical systems that will be affected by the work in this contract. Provide a report with photographs to the Owner indicating any problems or defects found. If no problems or system defects are submitted, the contractor shall be responsible for correcting problems found at the completion of the project that are determined to be caused by the work of this contract.
- B. Inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the owner prior to beginning work. If existing damage is not documented the contractor shall repair all damage to like new condition, that is determined to have been caused by the work in this contract.
- C. Verify circuiting arrangements are as shown on Drawings.
- D. Verify that abandoned wiring and equipment serve only abandoned facilities.
- E. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Architect/Engineer before disturbing existing installation.
- F. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

- B. Coordinate utility service outages with the owner and Utility Company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner and Architect/Engineer at least (72) hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Refer to section 260010 and Division 1 for additional requirements.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Notify Owner, Architect/Engineer, and local fire service at least (72) hours before partially or completely disabling system. Minimize outage duration. Refer to 283100 and Division 1 for additional requirements.

3.03 DEMOLITION EXISTING ELECTRICAL WORK

- A. Demolish existing electrical work under provisions of Division 01, Division 02 and this section.
- B. Remove existing installations to accommodate requirements for new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Provide blank cover for abandoned boxes which are not removed.
- F. Disconnect and remove abandoned panelboards and distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- I. Repair adjacent construction and finishes damaged during demolition work.
- J. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- K. Where branch circuit home run is called to be reused label circuit in junction box and remove all branch and switch leg wiring.
- L. Where removal of branch circuit wiring effects devices or fixtures upstream or downstream, make permanent connections to maintain circuits. Existing circuits to must remain active. All required connections to maintain existing circuits must be made after normal hours and coordinated with the owner.

3.04 EXISTING BACK BOXES

- A. Where it is practical, and they will not interfere with new work from any other trade, existing back boxes and raceway may be reused. Obtain the approval from the construction manager prior to reusing backboxes or raceways.

3.05 RESUPPORT OF DEVICES CONDUIT AND WIRING AFTER CEILING REMOVAL

- A. Where existing ceilings are removed re-support all conduit 8 ft on center and all open cabling 4 foot on center.
- B. Utilize open top cable hangers for supporting cables.
- C. Where existing equipment, fixtures or devices are scheduled for reuse in new ceilings, remove and store in safe dry space. Make temporary connections to maintain through wiring where devices are removed.

3.06 RELOCATION OF EXISTING ELECTRICAL WORK

- A. Where drawings indicate, equipment is to be relocated the contractor shall do all of the following:
 - 1. Disconnect and remove the device or piece of equipment.
 - 2. Clean, box and store the device or piece of equipment.
 - 3. Make temporary connections to maintain the system that is effected by the relocation
 - 4. Reinstall the device or piece of equipment where indicated on new work plans.

END OF SECTION 26 0015

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract including the General and Supplementary conditions and Division 1 Specification Sections apply to the work of this Section.

1.02 SUBMITTALS

NOT REQUIRED.

1.03 GENERAL REQUIREMENTS

- A. Electrical Contractor shall furnish, install and maintain temporary electric system for lighting and power as described herein.
- B. All temporary electric system work shall comply with all applicable OSHA Standards.
- C. All temporary electric system work shall comply with all applicable N.E.C. Standards and local regulations.
- D. Power shall be supplied from the source listed in Part 3.
- E. Temporary service shall be installed on the jobsite where appropriate for the level of construction and as directed by Architect.
- F. Temporary service and all devices and wiring shall be removed from the site when permanent facilities are available.
- G. Temporary services including wire and cabling shall not interfere or impede movement of construction vehicles.
- H. Contractor shall provide all maintenance necessary for continuous operation for temporary electric system throughout the duration of system operation.

PART 2 - PRODUCTS

2.01 PRODUCTS

- A. Refer to Sections 260190, 260533, 260519

PART 3 - EXECUTION

3.01 TEMPORARY SUB-FEED FROM EXISTING BUILDING TO WORK AREAS

- A. Provide temporary power from existing building panels to each construction area. Refer to phasing plans for requirements.
- B. Route temporary power through existing ceilings to work site.

- C. Verify power sources with construction manager. Utilize distribution panels near the work site. Each phase of work will be serviced from different existing distribution panels.
- D. Provide a 480-single phase – 120/240V single phase 45 KVA transformer to be used for temporary power from existing 480V distribution panels
- E. Provide a 175A main circuit breaker load center to service the temporary power called for.

3.02 TEMPORARY LIGHTING IN WORK AREAS

- A. Provide temporary branch circuits with weatherproof medium base lamp holders equipped with guards for lighting of 10 foot-candles in work area. Provide replacement lamps where required for the duration of system operation.
- B. Provide temporary lighting in all work areas.
- C. Provide temporary lighting for corridors, walk areas, stairs, etc. for safe entrance and egress.
- D. Existing fixtures scheduled for demolition may be used for temporary lighting in renovation areas. Temporarily resort these fixtures as required.
- E. Provide temporary lighting as required for security purposes for building exterior and applicable site locations, and building interior locations.
- F. Provide lighting in specific areas as directed by Architect.

3.03 TEMPORARY CONVENIENCE POWER IN WORK AREAS

- A. Provide temporary convenience power distribution for the use of tradesman hand tools and other devices as requested by construction trades.
- B. Branch circuits with GFCI type receptacle outlets for single phase 120 volt, 20-amp power.
- C. Convenience power distribution shall cover all work areas of building within a 100' extension cord reach. Each contractor using power shall provide their own ground fault device protection.

3.04 TEMPORARY EQUIPMENT POWER

- A. Provide temporary equipment power feeds for temporary heating equipment. Temporary heating equipment shall be furnished by others.
- B. Branch circuits for heating equipment shall be connections with single phase 208 volt, 30-amp power. Coordinate exact locations with HC.

3.05 TEMPORARY CONSTRUCTION TRAILERS

- A. Provide a 120/240V temporary power service from the existing National Grid utility pole to the trailer area on the construction site.
- B. Provide a 400A, 120/240V 1PH/3W MCB distribution panel with 60A breakers for each trailer.

C. Provide 60A feeds from the temporary panel to the following contractor trailers.

1. Construction Manager
2. General Construction Contractor
3. Plumbing Contractor
4. Fire Protection Contractor
5. HVAC Contractor
6. Electric Contractor

3.06 WIRE AND CABLES

- A. Exterior Locations: Site wiring shall be by overhead methods where possible. Overhead wiring shall be a minimum of 18' above grade. For other locations, wiring shall be run underground in GRS conduit.
- B. Interior Locations: Lighting circuits shall utilize suspended open type festoon style wiring. Power circuits shall be run flexible or rigid conduit as appropriate for each application.

END OF SECTION 26 0016

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

- A. Conduit and equipment supports.
- B. Anchors and fasteners.

1.03 REFERENCES

- A. Refer to Division 1.
- B. NECA Standard of Installation (National Electrical Contractors Association).
- C. NFPA 70 - National Electrical Code.

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 ANCHORING DEVICES

- A. Sleeve Anchors (FS FF-S-325 Group II, Type 3, Class 3): Molly/Emhart's Parasleeve Series, Phillips' Red Head AN, HN, FS Series, or Ramset's Dynabolt Series.
- B. Wedge Anchors (FS FF-S-325 Group II, Type 4, Class 1): Hilti's Kwik Bolt Series, Molly/Emhart's Parabolt Series, Phillips' Red Head WS, or Ramset's Trubolt Series.
- C. Self-Drilling Anchors (FS FF-S-325 Group III, Type 1): Phillips' Red Head Series S or Ramset's Ram Drill Series.
- D. Non-Drilling Anchors (FS FF-S-325 Group VIII, Type 1): Hilti's Drop-In Anchor Series, Phillips' Red Head J Series, or Ramset's Dynaset Series.
- E. Stud Anchors (FS FF-S-325 Group VIII, Type 2): Phillips' Red Head JS Series.

2.02 CAST-IN-PLACE CONCRETE INSERTS

- A. Continuous Slotted Type Concrete Insert, Galvanized:
 - 1. Load Rating 1300 lbs./ft.: Kindorf's D-986.
 - 2. Load Rating 2400 lbs./ft.: Kindorf's D-980.
 - 3. Load Rating 3000 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-H.
 - 4. Load Rating 4500 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-HD.

- B. Threaded Type Concrete Insert: Galvanized ferrous castings, internally threaded.
- C. Wedge Type Concrete Insert: Galvanized box-type ferrous castings, designed to accept bolts having special wedge shaped heads.

2.03 MISCELLANEOUS FASTENERS

- A. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work, selected from the following: Furnish galvanized fasteners for exterior use, or for items anchored to exterior walls, except where stainless steel is indicated.
 - 1. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
 - 2. Lag Bolts: FS FF-B-561, square head type.
 - 3. Machine Screws: FS FF-S-92, cadmium plated steel.
 - 4. Machine Bolts: FS FF-B-584 heads; FF-N-836 nuts.
 - 5. Wood Screws: FS FF-S-111 flat head carbon steel.
 - 6. Plain Washers: FS FF-W-92, round, general assembly grade carbon steel.
 - 7. Lock Washers: FS FF-W-84, helical spring type carbon steel.
 - 8. Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class and style as required to sustain load.
- B. Stainless Steel Fasteners: Type 302 for interior Work; Type 316 for exterior Work; Phillips head screws and bolts for exposed Work unless otherwise specified.

2.04 HANGER RODS

- A. Mid low carbon steel, unless otherwise specified; fully threaded or threaded each end, with nuts as required to position and lock rod in place. Unless galvanized or cadmium plated, provide a shop coat of red lead or zinc chromate primer paint.

2.05 "C" BEAM CLAMPS

- A. With Conduit Hangers:
 - 1. For 1 Inch Conduit Maximum: B-Line Systems Inc.'s BG-8, BP-8 Series, Caddy/Erico Products Inc.'s BC-8P and BC-8PSM Series, or GB Electrical Inc.'s HIT 110-412 Series.
 - 2. For 3 Inch Conduit Maximum: Appleton Electric Co.'s BH-500 Series beam clamp with H50W/B Series hangers, Kindorf's 500 Series beam clamp with 6HO-B Series hanger, or OZ/Gedney Co.'s IS-500 Series beam clamp with H-OWB Series hanger.
 - 3. For 4 Inch Conduit Maximum: Kindorf's E-231 beam clamp and E-234 anchor clip and C-149 series lay-in hanger; Unistrut Corp.'s P2676 beam clamp and P-1659A Series anchor clip with J1205 Series lay in hanger.
- B. For Hanger Rods:
 - 1. For 1/4 Inch Hanger Rods: B-Line Systems Inc.'s BC, Caddy/Erico Products Inc.'s BC, GB Electrical Inc.'s HIT 110, Kindorf's 500, 510, or Unistrut Corp.'s P1648S, P2398S, P2675, P2676.
 - 2. For 3/8 Inch Hanger Rods: Caddy/Erico Products Inc.'s BC, Kindorf's 231-3/8, 502, or Unistrut Corp.'s P1649AS, P2401S, P2675, P2676.

3. For 1/2 Inch Rods: Appleton Electric Co. BH-500 Series, Kindorf's 500 Series, 231-1/2, OZ/Gedney Co.'s IS-500 Series, or Unistrut Corp.'s P1650AS, P2403S, P2676.
4. For 5/8 Inch Rods: Unistrut Corp.'s P1651AS beam clamp and P1656A Series anchor clip.
5. For 3/4 Inch Rods: Unistrut Corp.'s P1653S beam clamp and P1656A Series anchor clip.

2.06 CHANNEL SUPPORT SYSTEM

- A. Channel Material: 12 gage steel.
- B. Finishes:
 1. Phosphate and baked green enamel/epoxy.
 2. Pre-galvanized.
 3. Hot dipped galvanized.
 4. Polyvinyl chloride (PVC), minimum 15 mils thick.
- C. Fittings: Same material and finish as channel.
- D. UL Listed Systems:
 1. B-line Systems Inc.'s B-22 (1-5/8 x 1-5/8 inches), B-12 (1-5/8 x 2-7/16 inches), B-11 (1-5/8 x 3-1/4 inches).
 2. Grinnell Corp.'s Allied Power-Strut PS 200 (1-5/8 x 1-5/8 inches), PS 150 (1-5/8 x 2-7/16 inches), PS 100 (1-5/8 x 3-1/4 inches).
 3. Kindorf's B-900 (1-1/2 x 1-1/2 inches), B-901 (1-1/2 x 1-7/8 inches), B-902 (1-1/2 x 3 inches).
 4. Unistrut Corp.'s P-3000 (1-3/8 x 1-5/8 inches), P-5500 (1-5/8 x 2-7/16 inches), P-5000 (1-5/8 x 3-1/4 inches).
 5. Versabar Corp.'s VA-1 (1-5/8 x 1-5/8 inches), VA-3 (1-5/8 x 2-1/2 inches).

2.07 MISCELLANEOUS FITTINGS

- A. Side Beam Brackets: B-Line Systems Inc.'s B102, B103, B371-2, Kindorf's B-915, or Versabar Corp.'s VF-2305, VF-2507.
- B. Pipe Straps:
 1. Two Hole Steel Conduit Straps: B-Line Systems Inc.'s B-2100 Series, Kindorf's C-144 Series, or Unistrut Corp.'s P-2558 Series
 2. One Hole Malleable Iron Clamps: Kindorf's HS-400 Series, or OZ/ Gedney Co.'s 14-G Series, 15-G Series (EMT).
- C. Deck Clamps: Caddy/Erco Products Inc.'s DH-4-T1 Series.
- D. Fixture Stud and Strap: OZ/Gedney Co.'s SL-134, or Steel City's FE-431.

- E. Supporting Fittings for Pendent Mounted Industrial Type Fluorescent Fixtures on Exposed Conduit System:
1. Ball Hanger: Appleton Electric Co.'s AL Series, or Crouse-Hinds Co.'s AL Series.
 2. Flexible Fixture Hanger: Appleton Electric Co.'s UNJ-50, UNJ-75, or Crouse-Hinds Co.'s UNJ115.
 3. Flexible (Hook Type) Fixture Hanger: Appleton Electric Co.'s FHMF, or Crouse-Hinds Co.'s UNH-1.
 4. Eyelet: Unistrut Corp.'s M2250.
 5. Eyelet with Stud: Kindorf's H262, or Unistrut Corp.'s M2350.
 6. Conduit Hook: Appleton Electric Co.'s FHSN, or Crouse-Hinds Co.'s UNH-13.
- F. Supporting Fasteners (Metal Stud Construction): Metal stud supports, clips and accessories as produced by Caddy/Erco Products Inc.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Where specific fasteners are not specified or indicated for securing items to in-place construction, provide appropriate type, size, and number of fasteners for a secure, rigid installation.
- B. Install anchoring devices and other fasteners in accordance with manufacturer's printed instructions.
- C. Make attachments to structural steel wherever possible.

3.02 FASTENER SCHEDULE

- A. Material:
 1. Use cadmium or zinc coated anchors and fasteners in dry locations.
 2. Use hot dipped galvanized or stainless-steel anchors and fasteners in damp and wet locations.
 3. For corrosive atmospheres or other extreme environmental conditions, use fasteners made of materials suitable for the conditions.
- B. Types and Use: Unless otherwise specified or indicated use:
 1. Cast-in-place concrete inserts in fresh concrete construction for direct pull-out loads such as shelf angles or fabricated metal items and supports attached to concrete slab ceilings.
 2. Anchoring devices to fasten items to solid masonry and concrete when the anchor is not subjected to pull out loads, or vibration in shear loads.
 3. Toggle bolts to fasten items to hollow masonry and stud partitions.

4. TPR fasteners to fasten items to plywood backed gypsum board ceilings.
5. Metallic fasteners installed with electrically operated or powder driven tools for approved applications, except:
 - a. Do not use powder driven drive pins or expansion nails.
 - b. Do not attach powder driven or welded studs to structural steel less than 3/16 inch thick.
 - c. Do not support a load, in excess of 250 lbs from any single welded or powder driven stud.
 - d. Do not use powder driven fasteners in precast concrete.

3.03 ATTACHMENT SCHEDULE

- A. General: Make attachments to structural steel or steel bar joists wherever possible. Provide intermediate structural steel members where required by support spacing. Select steel members for use as intermediate supports based on a minimum safety factor of 5.
 1. Make attachments to steel bar joists at panel points of joists.
 2. Do not drill holes in main structural steel members.
 3. Use "C" beam clamps for attachment to steel beams.
- B. Where it is not possible to make attachments to structural steel or steel bar joists, use the following methods of attachment to suit type of construction unless otherwise specified or indicated on the drawings:
 1. Attachment to Steel Roof Decking (No Concrete Fill):
 - a. Decking with Hanger Tabs: Use deck clamps.
 - b. Decking Without Hanger Tabs:
 1. Before Roofing Has Been Applied: Use 3/8 inch threaded steel rod welded to a 4 x 4 x 1/4 inch steel plate and installed through 1/2 inch hole in roof deck.
 2. After Roofing Has Been Applied: Use welding studs, or self-drilling/tapping fasteners. Exercise extreme care when installing fasteners to avoid damage to roofing.
 2. Attachment to Concrete Filled Steel Decks (Total thickness, 2-1/2 inches or more):

Before Fill Has Been Placed:

 - a. Use thru-bolts and fish plates.
 - b. Use welded studs. Do not support a load in excess of 250 pounds from a single welded stud.
 - c. After Fill Has Been Placed: Use welded studs. Do not support a load in excess of 250 lbs. from a single welded stud.
 3. Attachment to Cast-In-Place Concrete:
 - a. Fresh Concrete: Use cast-in-place concrete inserts.
 - b. Existing Concrete: Use anchoring devices.
 4. Attachment to Cored Precast Concrete Decks:
 - a. New Construction: Use thru-bolts and fish plates before Construction concrete fill is placed over decks.

5. Attachment to Hollow Block or Tile Filled Concrete Deck:
 - a. New Construction: Use cast-in-place concrete inserts by having Construction Work Contractor omitting blocks and pouring solid blocks with insert where required.
6. Attachment to Waffle Type Concrete Decks:
 - a. New Construction:
 1. Use cast-in-place concrete inserts in fresh concrete.
 2. If concrete fill has been applied over deck, thru-bolts and fish plates may be used where additional concrete or roofing is to be placed over the deck.
7. Attachment to Precast Concrete Planks: Use anchoring devices, except do not make attachments to precast concrete planks less than 2-3/4 inches thick.
8. Attachment to Precast Concrete Tee Construction:
 - a. New Construction:
 1. Use tee hanger inserts between adjacent flanges.
 2. Use thru-bolts and fish plates, except at roof deck without concrete fill.
 - b. Existing Construction:
 1. Use anchoring devices installed in webs of tees. Install anchoring devices as high as possible in the webs.
 - c. Do not use powder driven fasteners.
 - d. Exercise extreme care in drilling holes to avoid damage to reinforcement.
9. Attachment to Metal Stud Construction: Use supporting fasteners manufactured specifically for the attachment of raceways and boxes to metal stud construction.
 - a. Support and attach outlet boxes so that they cannot torque/twist. Either:
 1. Use bar hanger assembly, or:
 2. In addition to attachment to the stud, also provide far side box support.

3.04 CONDUIT SUPPORT SCHEDULE

- A. Provide number of supports as required by National Electrical Code. Exception: Maximum support spacing allowed is 4'-0" for conduit sizes 3 inches and larger supported from wood trusses.
- B. Use pipe straps and specified method of attachment where conduit is installed proximate to surface of wood or masonry construction.
 1. Use hangers secured to surface with specified method of attachment where conduit is suspended from the surface.
- C. Use "C" beam clamps and hangers where conduit is supported from steel beams.
- D. Use deck clamps and hangers where conduit is supported from steel decking having hanger tabs.
 1. Where conduit is supported from steel decking which does not have hanger tabs, use clamps and hangers secured to decking, utilizing specified method of attachment.
- E. Use channel support system supported from structural steel for multiple parallel conduit runs.
- F. Where conduits are installed above ceiling, do not rest conduit directly on runner bars, T-Bars, etc.
 1. Conduit Sizes 2-1/2 Inches and Smaller: Support conduit from ceiling supports or from construction above ceiling.

2. Conduit Sizes Over 2-1/2 Inches: Support conduit from beams, joists, or trusses above ceiling.

3.05 LIGHTING FIXTURE SUPPORT SCHEDULE

- A. General: Do not support fixtures from ceilings or ceiling supports unless it is specified or indicated on the drawings to do so.
 1. Support fixtures with hanger rods attached to beams, joists, or trusses. Hanger rod diameter, largest standard size that will fit in mounting holes of fixture.
 - a. Where approved, channel supports may span and rest upon the lower chord of trusses and be utilized for the support of lighting fixtures.
 - b. Where approved, channel supports may span and be attached to the underside of beams, joists, or trusses and be utilized for the support of lighting fixtures.
 2. Use 2 nuts and 2 washers on lower end of each hanger rod to hold and adjust fixture (one nut and washer above top of fixture housing, one nut and washer below top of fixture housing).
 - a. Where specified that an adequately supported outlet box is to support a fixture or be utilized as one point of support, support the box so that it may be adjusted to bring the face of the outlet box even with surface of ceiling.
- B. Number of Supports for Ceiling Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer, or shown on the drawings.
 1. Commercial and Industrial Fixtures:
 - a. Support individual fixtures less than 2 feet wide at 2 points.
 - b. Support continuous row fixtures less than 2 feet wide at points equal to the number of fixtures plus one. Uniformly distribute the points of support over the row of fixtures.
 - c. Support individual fixture 2 feet or wider at 4 corners.
 - d. Support continuous row of fixtures 2 feet or wider at points equal to twice the number of fixtures plus 2. Uniformly distribute the points of support over the row of fixtures.
 - e. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.
- C. Number of Supports for Wall Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer, or shown on the drawings.
 1. Commercial and Industrial Fixtures:
 - a. Support individual fixtures 2 feet long or less at 2 points.
 - b. Support individual fixtures over 2 feet long at 3 points.
 - c. Support continuous row fluorescent fixtures at points equal to twice the number of fixtures. Uniformly distribute the points of support.
 - d. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

3.06 CHANNEL SUPPORT SYSTEM SCHEDULE

- A. Use channel support system where specified or indicated on the drawings.

- B. Channel supports may be used, as approved, to accommodate mounting of equipment.
- C. Material and Finish:
 - 1. Dry Locations: Use 12 gage steel channel support system having any one of the specified finishes.
 - 2. Damp Locations: Use 12 gage steel channel support system having any one of the specified finishes except green epoxy/enamel.
 - 3. Wet Locations: Use 12 gage steel channel support system having hot dipped galvanized, or PVC finish.

END OF SECTION 26 0190

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

- A. Nameplates and labels.
- B. Wire and cable markers.
- C. Conduit markers.

1.03 REFERENCES

- A. Refer to Division 1.
- B. NFPA 70 - National Electrical Code.

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 NAMEPLATES AND LABELS

- A. Nameplates: Engraved three-layer laminated plastic, black letters on white background
 - 1. Locations:
 - a. Outside of each electrical panel. Indicate panel name and the upstream panel and breaker number that the panel is serviced from.
 - b. Control equipment enclosure. Indicate equipment name and branch circuit.
 - c. Disconnects Indicate equipment name and branch circuit.
 - d. Distribution panel breakers. Indicate load served.
 - 2. Letter Size: 1/8 -inch letters.
- B. Labels: Circuit designation shall be indicated with clear adhesive tape, 3/16 inch black letters on clear background. Use only for identification of individual wall switches and receptacles and control device stations. Tape label shall be adhered to the faceplate of each device.
- C. Provide flash protection label per NEC 110.16 for equipment furnished under this Contract including switchboards, panelboards, industrial control panels and motor control centers. Seton #M0547; or equal.

2.02 WIRE MARKERS

- A. Description: Tape type wire markers.
- B. Locations: Each conductor at panelboard gutters and each load connection.
- C. Legend: Branch circuit or feeder number indicated.

2.03 UNDERGROUND WARNING TAPE

- A. Location:
 - 1. Along length of each underground conduit buried 12" below finished grade.
 - 2. Yellow with black lettering, 6" wide tape, "CAUTION – Underground Electric".
 - 3. Orange with black lettering, 6" wide detectable tape made of durable plastic encased aluminum, "CAUTION – Fiber Optic Cable".

2.04 PANEL SCHEDULES

- A. Provide complete type written directory for each panelboard listing room number, function, etc., for each circuit breaker.
- B. Panel directory must also include the up-stream panel that services the panel. (i.e. "Fed from MDP Circuits 2,4,6")
- C. Include a Microsoft word or excel file with all panel schedules as part of the close out submittals.

2.05 DEVICES

- A. Provide a tape label on all receptacle and switch cover plates, power poles, etc. listing panel designation and circuit number. Tape shall be attached to outside of receptacle or switch cover plates.
- B. In permanent marker write the panel and circuit number on the wall behind receptacle cover plate or inside receptacle back box.

2.06 JUNCTION AND PULL BOXES

- A. Identify junction and pull boxes for particular service such as power, lighting, fire alarm, telephone, intercom, public address, nurse call, etc. using stencil lettering on cover.

2.07 CONDUIT

- A. Provide adhesive marking labels for raceway and metal-clad cable. The labels shall indicate voltage and service, and be located above ceilings every 75 feet and on wall mounted conduit in mechanical and equipment rooms.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

- A. Install nameplate and label parallel to equipment lines.
- B. Secure nameplate to equipment front using adhesive.

- C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

END OF SECTION 26 0195

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 WORK INCLUDED

- A. Conductors.
- B. MC Cable.
- C. Terminations.

1.03 SUBMITTALS

- A. Schedule of all wiring and cable usage.
- B. Product data sheets for all wire and cable types.

PART 2 - PRODUCTS

2.01 CONDUCTORS

- A. Feeder, branch circuit and control wiring:
 - 1. Annealed Copper, 98% conductivity.
 - 2. Minimum wire size:
 - a. #12 AWG for branch circuits
 - b. #14 AWG for control and signal circuits
 - 3. #8 AWG Wire and above shall be stranded.
 - 4. 600-volt insulation for all wiring above 50 volts.
 - 5. 300-volt insulation permitted for all wiring below 50 volts.
 - 6. Thermal plastic with PVC insulation with nylon jacket, suitable for wet or dry locations, THHN/THWN 90 degree Celsius.
 - 7. 90-degree C maximum operating temperature rating.
 - 8. UL 83 Listed
- B. Lighting fixture wire
 - 1. FREP/CPE coated stranded copper,
 - 2. Flame retardant EPR Insulation and CPE jacket.
 - 3. UL 44 listed

C. Flexible cords and cables shall be Type "SO" or "SJO."

D. Color Coding:

1. All circuits shall be color coded according to the following schedule:

Voltage	A PHASE	B PHASE	C PHASE	NEUTRAL
208Y/120V, 3 Phase	Black	Red	Blue	White
480Y/277V, 3 Phase	Brown	Orange	Yellow	Gray
*ALL GROUNDING CONDUCTORS SHALL BE GREEN				

2. #6 AWG and smaller shall have insulation continuously colored as called for above.
3. #4 AWG and larger may be identified using a minimum 3" tape band.
4. Color code all conductors at all pull boxes, enclosures, and terminations.
5. Switched legs shall be identified with the same color insulation as the phase leg.

E. Acceptable manufacturers:

1. Cablec
2. Southwire
3. Okonite
4. Rome Cable
5. Pirelli

2.02 TYPE MC METAL CLAD CABLE

A. Construction:

1. Galvanized Interlocking Steel Strip outer shield
2. Stranded or solid copper conductors, each individually insulated, and enclosed in an armor of flexible metal tape.
3. Suitable for wet or dry locations.
4. Suitable for cable tray installations.
5. Do not install direct buried, in concrete, or in the presence of corrosive vapors.
6. Provide with separate integral grounding conductor.
7. Support every 6 feet.
8. Manufactured and installed in accordance with NEC Article 330
9. Provide red stripe on outer shield where utilized for fire alarm wiring.
10. Make: Acceptable manufacturers:
 - a. AFC
 - b. Southwire
 - c. United Copper Industries

2.03 METAL CLAD COMBINATION LIGHTING POWER AND CONTROL CABLE.

- A. Cable Shall have following construction
 - 1. Armor: Galvanized Interlocking Steel Strip (blue armor) or Interlocking Aluminum Strip
 - 2. Solid or Stranded Copper Conductors
 - 3. Insulated Conductor Type THHN
 - 4. Neutral Conductor: White or Gray
 - 5. Control Cables: 16 AWG Solid TFN Twisted jacketed pair (Purple/Gray)
 - 6. Insulation Permitting conductors of control circuits to be placed in a cable with conductors of electric light, power, or Class 1 circuits
- B. Standards
 - 1. UL 66, 83, 1479, 1569, 1581, 2556, File Reference E80042
 - 2. NEC 250.118, 300.22(C), 392, 396, 330, 501, 502, 503, 530, 504, 505, 518, 520, 530, 645, 725
 - 3. Federal Specification A-A-59544 (formerly J-C-30B)
 - 4. Meets all applicable OSHA and HUD Requirements
 - 5. Cable Tray Rated
 - 6. UL Classified 1, 2, and 3 hour through penetration (Fire Stop) product, R 14141
 - 7. Environmental Air-Handling Space Installation per NEC 300.22(C)
 - 8. Power and/or lighting as well as signal and/or control conductors per NEC Section 725.136(I)(1)
- C. Design Make: AFC MC Tuff Luminary Cable

2.04 LOW VOLTAGE CONNECTORS AND TERMINATIONS

- A. Straight Splices, #26 AWG to #10 AWG:
 - 1. Nylon Insulated compression butt-splices.
 - 2. 600 volt, 90 degree C rated.
 - 3. Make: Burndy "Insulink", T&B "Sta-Kon", or approved equal
- B. Straight Splices, #8 AWG and Larger:
 - 1. Two way, long barrel, compression type, copper
 - 2. Provide heat shrink tubing over splice.
 - 3. 600 volt rated.
 - 4. Make: Burndy "Hylink", T&N 54800 Series, or approved equal.
- C. Pigtail Splices, #26 AWG to #10 AWG:
 - 1. Twist type pressure connector.
 - 2. 600 volt rated, 105 degree C.
 - 3. Size as required for number and size of conductors used.
 - 4. Make: T&B Scotchlock, or approved equal
- D. Three Way Splices, #8 AWG and Larger:
 - 1. Three way, long barrel, compression type, copper.

2. Provide tape or heat shrink tubing over splice.
 3. 600 volt rated.
 4. Make: Burndy "Hylink", T&B 54700 Series, or approved equal.
- E. Lug Terminations for Control and Signal Wiring:
1. Nylon insulated fork with compression termination of #26 AWG to #10 AWG.
 2. Nylon insulated ring with compression termination for #8 AWG and larger.
 3. 300 volt rated.
 4. Make: Burndy "Insulug", T&B "Sta-Kon", or approved equal.
- F. Lug Terminations for Power Wiring:
1. Long barrel, compression type, copper body, on hole for #8 AWG to #2/0 AWG.
 2. Long barrel, compression type, copper body, two hole, for #3/0 AWG and larger.
 3. 600 volt rated.
 4. Make:
 - a. One-hole lug: Burndy "Hylug", T&B 54900 Series, or approved equal.
 - b. Two-hole lug: Burndy "Hylug", T&B 54800 Series, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Route wire and cable as required to meet Project Conditions.
- B. Install cable in accordance with the NECA "Standard of Installation."
- C. Use stranded conductors for control circuits.
- D. Use conductor not smaller than 12 AWG for power and lighting circuits.
- E. Use conductor not smaller than 16 AWG for control circuits.
- F. Use 10 AWG conductors for 20 amperes, 120 volt branch circuits longer than 100 feet.
- G. Identify and color code wire and cable under provisions of this section. Identify each conductor with its circuit number or other designation indicated.
- H. Install cables for emergency power feeders and circuits in raceway as called for after the entire raceway system has been completed.
- I. Install splices and connections in accessible outlet, pull, and junction boxes.
- J. Insulate all splices and connections with UL Labeled plastic tape, heat shrink tubing, or plastic molded caps.
- K. All wiring systems shall be properly grounded and continuously polarized throughout, following the color coding specified.
- L. Provide a green equipment ground with all feeders and all branch circuits' size per the NEC.

- M. Provide dedicated white insulated neutral conductor for each branch circuit. Shared neutrals are not allowed.
- N. Install a maximum of three phase conductors, three neutral conductors, and one grounding conductor in each home run. (Obtain approval for additional conductor fill where field conditions require. Adhere to NEC de-rating requirements.)
- O. Provide stranded wire to motors, transformers, equipment, and vibrating machinery.
- P. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Owner's Representative and receive written approval for splicing prior to installation of feeder(s). Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors.
- Q. Use pulling means including fish tape, cable, and rope and basket type grips which will not damage cables or raceways. Use approved mechanical pullers for feeders and branch circuits as required for #6 AWG cable and larger. Do not use mechanical means to pull conductors No. 8 or smaller.
- R. Branch circuit conductors installed in panelboards, and control conductors installed in control cabinets and panels shall be neatly bound together using "Ty-Raps" or equivalent.
- S. Reconnect branch circuit wiring at panelboards as required to obtain a balanced three phase load on the feeders.
- T. Properly splice and neatly coil extraneous wires in outlet boxes.
- U. Wiring in panelboards and equipment enclosures etc. shall be neatly trained and arranged so as not to preclude access to the space or equipment contained therein. Provide all additional cable supports and ties required to comply.
- V. The system shall be properly grounded and continuously polarized throughout, following the color coding specified.
- W. Wiring within panelboards, control cabinets, pull boxes, wiring troughs and annunciator and/or alarm panels shall be neatly bundled together with ties not requiring tools to install. Two, three and four wire circuits emerging from the bundle shall be trained and tied individually.
- X. Where multiple conductors are installed in a common raceway they shall be pulled simultaneously. Use of pulling compound or lubricant shall be avoided unless absolutely necessary. Where pulling lubricant is required, use UL approved compounds approved for cable type. Lubricant shall meet all OSHA and Toxic Control Act standards.

APPLICATION	CABLE TYPES	DESIGN MAKE
General purpose Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon	Ideal - Yellow 77
High Temperature Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Ideal - Yellow 190

Utility construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua-Gel II
Cold Weather Construction & Maintenance	Rubber, Neoprene, Nylon PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua-Gel CW

3.02 CIRCUITING

- A. The following takes precedence over the drawings:
1. General purpose receptacle and lighting branch circuits may be combined in single conduits in accordance with NEC requirements and restrictions.
 2. Conductors serving individual pieces of equipment or grouped equipment or isolated ground branch circuits shall not be combined.
 3. Provide dedicated Neutrals.

3.03 SPLICES

- A. Dry locations: For conductors #10 AWG and smaller use standard spring type pressure connectors or compression type connectors with insulating jackets.
- B. For conductors #8 AWG and larger use compression type connectors and insulate in accordance with manufacturer's recommendations.
- C. Damp locations: Use same type splices as indicated for dry locations and wrap with moisture sealing tape.
- D. Wire runs shall be continuous. All splicing shall be done only in accessible boxes.

3.04 LOW VOLTAGE CONTROL WIRING

- A. Low voltage control wiring shall not be run in same conduit system as power feeds. All low voltage control wiring in equipment shall be neatly bundled, identified and installed remote from any and all mechanical moving parts. All low voltage control wiring in walls shall be installed in conduit, the same as required for power wiring. All low voltage wiring above inaccessible ceilings shall be installed in conduit. All low voltage wiring exposed in finished spaces shall be installed in wiremold surface raceway. All low voltage wiring exposed in unfinished spaces shall be installed in conduit. All low voltage control wiring above accessible ceilings shall be bundled, neatly run at right angles and/or parallel to building steel, tied to steel as high as possible with no more than 3" sags; wire may not be laid on ceiling framing or supported by ceiling framing. Low voltage wiring shall not be run between decking flutes or above structural members.

3.05 TYPE MC METAL CLAD CABLE

- A. MC Cable shall be permitted for branch circuit wiring only if they 100% concealed above a drop ceiling.
- B. All branch circuit wiring in the call center, IT Server room, and the War Room/Training and the adjoining support rooms must be installed in conduit.
- C. Type MC Cable is not permitted for panelboard feeders.
- D. MC cable shall not be allowed for branch circuit wiring exposed in finished spaces.
- E. Support cable at intervals not exceeding 4 feet.
- F. Bending radius shall comply with Article 330.24 of the NEC.
- G. Provide insulating bushing at all termination points between the metal sheath and outlet or junction box.
- H. Type MC Cable shall not be installed exposed with the exception of fixture drops in mechanical or equipment rooms. Secure the cable to fixture hangers using nylon or plastic ties.

END OF SECTION 26 0519

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

- A. Grounding electrodes materials.
- B. Grounding and bonding conductor materials.
- C. Equipment grounding and bonding requirements.

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. B3: Soft or Annealed Copper Wire.
 - 2. B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft.
 - 3. B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.
- B. Institute of Electrical and Electronic Engineers (IEEE):
 - 1. 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - 2. 1100: Powering and grounding sensitive electronic equipment.
- C. International Electrical Testing Association (NETA).
- D. National Fire Protection Association (NFPA):
 - 1. 70: National Electrical Code (NEC).
 - 2. 780: Lightning Protection Code.
- E. Occupational Safety and Health Administration (OSHA):
 - 1. 29CFR 1910.7 Definitions and requirements for Nationally Recognized Testing Laboratories (NRTL).
- F. Underwriters Laboratories (UL):
 - 1. 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
 - 2. 467: Grounding and Bonding Equipment.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7, or a full member company of NETA.
 - 1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in PART 3.
- B. Comply with NFPA 70, National Electrical Code.
- C. Comply with UL 467.
- D. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

1.05 SUBMITTALS

- A. Product Data for grounding wiring, grounding rods, connectors and connection materials, ground busses or plates, identification materials and grounding fittings.
- B. Field tests showing that the service entrance and generator grounding meets required resistance levels.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Kearney/Cooper Power Systems.
 - 2. Lyncole XIT Grounding.
 - 3. Salisbury: W. H. Salisbury & Co.
 - 4. Thomas & Betts, Electrical.
 - 5. Chance/Hubbell.
 - 6. O-Z/Gedney Co.; a business of the EGS Electrical Group.

2.02 WIRE AND CABLE GROUNDING CONDUCTORS

- A. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding. The requirements below apply for new cables installed as well as for upgrading of identification of existing cables as indicated on drawings.
 - 1. Material: Copper. Use only copper wire for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. Equipment Grounding Conductors: Insulated with green color insulation.
- C. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.

- D. Bare Copper Conductors: Conform to the following:
 - 1. Solid Conductors: ASTM B3.
 - 2. Assembly of Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.
- E. Color coding of ground cables - Where new or existing cables are concealed and not color-coded, any exposed portion of the cable and each end of the cable for a minimum of 2 feet shall be color coded by green tape overlaid with bright tracer color tape to form the tracer. Where routed through raceways, wire ways, cable trays or under raised floors, the color-coding shall be such that by removing or opening any cover, color-coding shall be visible. Where conductors are routed through cable trays, color-coding for a minimum length of 4 inches shall be accomplished at intervals not exceeding three feet between marking.

2.03 MISCELLANEOUS CONDUCTORS

- A. Grounding Plates: Bare or tinned, annealed-copper. Size as per specifications or larger as indicated on drawings.
- B. Braided Bonding Jumpers: Where electrical continuity across shock mounts is necessary, bonding jumpers shall be installed across each shock mount. Jumpers of this application should have a maximum thickness of 0.025 inch, so that the damping efficiency of the mount is not impaired. In severe shock and vibration environments, solid straps may be corrugated, or flexible tinned copper wire braid may be used. Braids are to be terminated with tinned copper ferrules.
- C. Raceway Bonding Jumpers: Copper, minimum size #6 AWG unless otherwise noted.

PART 3 - EXECUTION

3.01 GENERAL

- A. A separate ground conductor (green wire) shall be installed in all raceways for feeders, power and receptacle branch circuits and where called for on drawings.
- B. Switchboards shall have a separate ground bus bonding all cubicles together.
- C. Equipment grounding terminals of normal and essential Panelboards serving common patient areas shall be bonded together.
- D. All distribution and branch circuit panels shall have a separate ground bar
- E. All metallic conduits 1-1/4" or larger shall have grounding bushings.
- F. All type SO cord, or equivalent, shall have a separate ground wire (green) of equal size to circuit conductor.
- G. Equipment ground conductor shall be copper with Type THHN insulation, green only, up to and including #4; larger sizes may be bare conductor, or black and identified with green tape.
- H. Paint, grease or other contaminates shall be cleaned from all surfaces before bonding ground conductor. (Painted surfaces shall be sanded and cleaned.)

- I. Equipment Grounding Conductors: All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings. Equipment grounding conductors shall be green insulated copper conductors unless otherwise indicated.
 - 1. Install green, equipment grounding conductor with all feeder and branch circuit conductors.
- J. Signal and Communication Systems: For telephone, fire alarm, security, voice, and data systems in the equipment room, provide a #4/0 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
- K. Service Locations and Wiring Closets: Terminate grounding conductor on a multipoint ground plate.
- L. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- M. Enclosures: Ground all enclosures of electrical and electronic wiring and distribution equipment in accordance with requirements of the NEC.
- N. Conduit or cable shields shall not be used as the equipment grounding conductor.
- O. Equipment Enclosure Grounding: Bare wire, wrapped around connecting screws or mounting bolts and screws is not acceptable as a grounding connection. All ground lugs shall be of a noncorrosive material suitable for use as a grounding connection, and must be compatible with the type of metal being grounded. Ground lugs shall be mounted on clean, bare metal surfaces that are free of paint, rust, etc. Wire brush clean each surface to remove paint or oxidation prior to bolting jumper connectors in place. In general use tinned copper connectors for connections of dissimilar metals. Use of bimetal connectors shall only be allowed in special circumstances and only with the prior written approval

3.02 CONNECTIONS

- A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Use for connections to structural steel, for underground connections, and were indicated on drawings. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable and will be redone at the contractor's expense. Utilize 'smokeless' type weld kits for all exothermic welds performed in interior of structure
- C. Terminate insulated equipment grounding conductors for feeders with pressure-type grounding lugs. Where metallic raceways terminate at non-metallic or non-conductive housings, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.

- D. Raceway Grounding: Surface metal raceways, wireways, or cable trays or cable rack systems shall be installed in a manner that ensures electrical continuity. Short insulated green copper bonding jumpers shall be installed between adjacent raceway sections, on both sides of each joint, to ensure proper bonding. Unless otherwise indicated, the minimum size for these bonding jumpers shall be No. 6 AWG. Jumpers shall be provided with compression connectors at each end of cable. Surface metal raceways, wireways, cable trays or cable rack systems shall be field drilled to provide bolting point for securing bonding jumper. Wire brush clean each surface to remove paint or oxidation prior to bolting jumper connectors in place. Bolts and hardware shall be as per details or as approved for grounding purposes. All metallic raceway penetrations into a facility structure shall be bonded to the earth electrode system.
- E. Other Grounding Systems: Any additional grounding systems used for electronic equipment shall be connected to the facility main ground plate, structural steel or exterior earth electrode system as shown on drawings.
- F. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with torque tightening values specified in UL 486A.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Mechanical connections using a Burndy "Hyground Connector", Thomas and Betts Compression Connector or equivalent equipment when operated at the manufacturers recommended pressure to develop a minimum force of 12 tons is acceptable as approved pressure connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on ground conductor. Hydraulically crimped connectors are not acceptable in the lightning protection system.

3.03 RACEWAY SYSTEMS

- A. All metal supports, cable trays, frames, sleeves, brackets, braces, etc. for the raceway system, panelboards, switchboards, switches, enclosures, starters, controls, etc., which are not rigidly secured to and in contact with the raceway system, or which are subject to vibration and loosening, shall be bonded to the raceway system. Size the bonding conductor in accordance with NEC Article 250, Table 250-122.
- B. Terminate rigid conduit at all boxes, cabinets, and enclosures tightly with two locknuts and a bushing.
- C. Conduit which runs to or from all boxes, cabinets, or enclosures having concentric or eccentric knockouts which partially perforate the metal around the conduit and hence impair the continuity of system ground circuits shall be provided with bonding jumpers sized in accordance with NEC Article 250, Table 250-122. Connect the bonding jumper between a grounding type bushing on the conduit and a ground bus or stud inside the box, cabinet, or enclosure.
- D. Provide bonding jumpers sized in accordance with NEC Article 250, Table 250-122 for all conduit expansion joints.
- E. Provide a grounding conductor in all flexible metallic conduit and liquid-tight conduit, sized in accordance with NEC Article 250, Table 250-122.
- F. Provide a grounding conductor in all nonmetallic runs of conduit and raceway, sized in accordance with NEC Article 250, Table 250-122.
- G. Provide isolated ground conductors of systems as called for on the plans.

H. Provide bonding bushings and connections in all of the following:

1. Service equipment enclosures.
2. Openings with eccentric or concentric knockouts.
3. Openings using reducing washers.
4. Hazardous locations.
5. Greater than 250V to ground systems.

3.04 SECONDARY ELECTRICAL SYSTEMS

- A. Solidly ground all transformer neutral conductors and enclosures to building steel, or a cold-water pipe 1" or larger in size as called for in Table 250-122 of the National Electrical Code.
- B. Provide an equipment grounding conductor from the point of termination back to the ground bus of the serving panelboard, switchboard, or transformer. Do not splice equipment grounding conductors.
- C. Provide an equipment grounding conductor from the point of termination back to the ground bus of the serving panelboard, switchboard, transformer, or switchgear.
- D. The grounding conductors contained in the interstices of interlocked armor cable shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.

3.05 TESTS

- A. Grounds and grounding systems shall have a resistance to solid earth ground not exceeding following values:
 1. For grounding non-current carrying metal parts associated with secondary distribution system: 25 Ohms.
- B. Providing grounding tests to verify the above values. Where these values are not met, add additional ground rods or connections in order to meet these values.

END OF SECTION 26 0526

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 WORK INCLUDED

- A. Metal conduit.
- B. Liquid tight flexible metal conduit.
- C. Electrical metallic tubing.
- D. Non-metallic conduit.
- E. Flexible metal conduit.
- F. Fittings and conduit bodies.

1.03 SUBMITTALS

- A. Submit for approval a list of each product and the manufacturer.

1.04 REFERENCES

- A. ANSI-C80.2, 1983: Specification for Rigid Steel Conduit, Enameled.
- B. ANSI C80.3: Electrical Metallic Tubing, Zinc Coated.
- C. ANSI/NEMA FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- D. NECA "Standard of Installation."
- E. NEMA TC 2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
- F. NEMA TC 3: PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- G. NEMA, RN1, 1986: PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- H. NEMA, TC 6, 1983: PVC and ABS Plastic Utilities Duct for Underground Installations.
- I. NEMA, TC 8, 1983: Extra strength PVC Plastic Utilities Duct for Underground Installations.
- J. NEMA, TC 9, 1983: Fittings for ABS and PVC Plastic Utilities Duct and Fittings for Underground Installation.
- K. NEMA, TC 10, 1983: PVC and ABS Plastic Communications Duct and Fittings for Underground Installation.
- L. The following U.L. Standards:
 - 1. UL 1, 1985: Flexible Metal Electrical Conduit.
 - 2. UL 3, 1984: Flexible Nonmetallic Tubing for Electric Wiring.
 - 3. UL 6, 1981: Rigid Metal Electrical Conduit.
 - 4. UL 360, 1986: Liquid tight Flexible Steel Conduit, Electrical.
 - 5. UL 514B, 1982: Fittings for Conduit and Outlet Boxes.
 - 6. UL 651, 1981: Schedule 40 and 80 PVC Conduit.
 - 7. UL 797, 1983: Electrical Metallic Tubing.
 - 8. UL 870, 1985: Electrical Wireways, Auxiliary Gutters and Associated Fittings.

PART 2 - PRODUCTS

2.01 CONDUIT REQUIREMENTS

- A. Minimum Size: 3/4" unless otherwise specified.
- B. Underground Installations:
 - 1. Use thick wall non-metallic conduit.
 - 2. Under Slab on Grade: Use thick wall non-metallic conduit.
 - 3. Minimum Size: 1".
- C. Outdoor Locations, Above Grade: Use rigid steel conduit.
- D. In Slabs Above Grade:
 - 1. Use rigid steel conduit
- E. Indoor:
 - 1. Concealed: Use electrical metallic tubing.
 - 2. Exposed: Use EMT unless otherwise called for.

2.02 RIGID GALVANIZED STEEL CONDUIT

- A. Steel, hot dipped galvanized on the outside and inside, UL categorized as Rigid Ferrous Metal Conduit identified on UL Listing Mark as Rigid Metal Conduit - Steel or Rigid Steel Conduit.
- B. Acceptable manufacturers:
 - 1. LTV Steel
 - 2. Triangle
 - 3. Allied Tube
 - 4. Steel Duct
 - 5. Wheatland

2.03 ELECTRICAL METALLIC TUBING

- A. Steel, galvanized on the outside and enameled on the inside, UL categorized as Electrical Metallic Tubing (identified on UL Listing Mark as Electrical Metallic Tubing).
- B. Acceptable manufacturers:
 - 1. Triangle
 - 2. Wheatland
 - 3. Allied Tube
 - 4. Steel Duct
 - 5. LTV Steel

2.04 FLEXIBLE METAL CONDUIT

- A. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocked, zinc coated strip steel. Interior surface shall be free from burrs or sharp edges. UL categorized as Flexible Metal Conduit (identified on UL Listing Mark as Flexible Steel Conduit or Flexible Steel Conduit Type RW).
- B. Acceptable manufacturers:
 - 1. Anaconda
 - 2. American Flexible Conduit Co.
 - 3. O-Z/Gedney
 - 4. Thomas and Betts

2.05 LIQUID TIGHT FLEXIBLE METAL CONDUIT

- A. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocking zinc coated strip steel. Interior surfaces shall be free from burrs and sharp edges. Provide with a liquid-tight jacket of flexible polyvinyl chloride (PVC). UL categorized as liquid-tight flexible metal conduit (identified on UL Listing Mark as Liquid-Tight Flexible Metal Conduit, also specifically marked with temperature and environment application data).
- B. Acceptable manufacturers:
 - 1. Allied
 - 2. American Flexible Conduit
 - 3. Carlon
 - 4. Thomas and Betts

2.06 RIGID NON-METALLIC PVC CONDUIT

- A. Extra-Heavy wall conduit: Schedule 80, constructed of polyvinyl chloride, rated for use with 90-degree C conductors, and UL listed for direct burial and normal above ground use.
- B. Acceptable manufacturers:
 - 1. Carlon/Div. of Lamson and Sessions
 - 2. Beck Mfg./Picoma Industries
 - 3. Cantex Inc.
 - 4. National Pipe & Plastics Inc.
 - 5. Ipex Inc.

2.07 FITTINGS AND ACCESSORIES

- A. Rigid galvanized steel fittings shall be fully threaded and shall be of the same material as the respective raceway system.
- B. Fittings for electrical metallic tubing shall be single screw indenter fittings for conduits up to 2" and double screw indenter fittings for conduits 2" and larger.
- C. Fittings for flexible metal conduit shall be center stopped, insulated throat, U.L. E-11852 listed.
- D. Fittings for liquidtight flexible metal conduit shall have zinc plated steel ferrule, compression type with sealing ring.

- E. Fittings for rigid non-metallic conduit shall be solvent cemented in accordance with the manufacturer's instructions.
- F. Connectors shall have insulated throat up to and including 1" size. For sizes 1-1/4" and larger, provide plastic insulating bushing.
- G. Die-cast or pressure cast fittings are not permitted.
- H. Provide conduit bodies' types, shapes and sizes as required to suit application and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
- I. Insulated Bushings:
 - 1. Threaded, malleable iron/zinc electroplate with 105 degrees C minimum plastic insulated throat; Appleton Electric Co.'s BU50I Series, Cooper/Crouse-Hinds' 1031 Series, OZ/Gedney Co.'s IBC-50 Series, Raco Inc.'s 1132 Series, Steel City/T & B Corp.'s BI-901 Series, or Thomas & Betts Corp.'s 1222 Series.
 - 2. Threaded malleable iron with 150 degrees C plastic throat; Appleton Electric Co.'s BU501 Series, Cooper/Crouse-Hinds' H1031 Series, or OZ/Gedney Co.'s IBC-50 Series.
- J. Plastic Bushings for 1/2 and 3/4 Inch Conduit:
 - 1. 105 degrees C minimum temperature rating; Appleton Electric Co.'s BBU50, BBU75, Blackburn (T & B Corp.'s) 50 BB, 75 BB, Cooper/Crouse-Hinds' 931,932, or OZ/Gedney Co.'s IB-50, IB-75, Raco Inc.'s 1402, 1403, Steel City/T & B Corp.'s BU-501, BU-502, or Thomas & Betts Corp.'s 222, 223.
 - 2. 150 degrees C temperature rating; Appleton Electric Co.'s BBU50H, BBU75H, Cooper/Crouse-Hinds' H-931, H-932, or OZ/Gedney Co.'s A-50, A-75.
- K. Insulated Grounding Bushings:
 - 1. Threaded, malleable iron/zinc electroplate with 105 degrees C minimum plastic insulated liner, and ground lug; Appleton Electric Co.'s GIB-50 Series, Cooper/Crouse-Hinds' GLL Series, OZ/Gedney Co.'s IBC-50L Series, Raco Inc.'s 1212 Series, Steel City/T & B Corp.'s BG-801 (1/2 to 2") Series, or Thomas & Betts Corp.'s 3870.
 - 2. Threaded malleable iron/zinc electroplate with 150 degrees C plastic insulated liner, and ground lug; Appleton Electric Co.'s GIB Series, Cooper/Crouse-Hinds' HGLL Series, or OZ/Gedney Co.'s IBC-50L Series, or Thomas & Betts Corp.'s 3870.
- L. Sealant for Raceways Exposed to Different Temperatures: Sealing compounds and accessories to suit installation; Appleton Electric Co.'s DUC, or Kwiko Sealing Compound with fiber filler, Cooper/Crouse-Hinds' Chico A Sealing Compound with Chico X fiber, Electrical Products Division 3M Scotch products, OZ Gedney Co.'s DUX or EYC sealing compound with EYF damming fiber, or Thomas & Betts Corp.'s Blackburn DX.
- M. Vertical Conductor Supports: Kellems/Hubbell Inc.'s Conduit Riser Grips, or OZ/Gedney Co.'s Type M, Type R.
- N. Pulling-In-Line for Installation in Spare and Empty Raceways: Polypropylene monofilament utility line; Greenlee Textron Inc.'s Poly Line 430, 431, or Ideal Industries Powr-Fish Pull-Line 31-340 Series.

- O. Acceptable manufacturers:
 - 1. O.Z. Gedney
 - 2. Steel City
 - 3. Thomas & Betts
 - 4. Cooper Crouse-Hinds
 - 5. Carlon
 - 6. Raco

2.08 EXPANSION FITTINGS

- A. Galvanized steel expansion joints for RGS or EMT conduit, PVC for PVC conduit. Minimum 4" movement in either direction.
- B. Weatherproof for outdoor applications.
- C. At expansion joints in concrete pours, provide Deflection/Expansion fittings capable of movement of 3/4" in all directions from the normal.
- D. Design Make: O.Z./Gedney, Type "AX" (exposed), "DX" (Concrete Pour)
- E. Acceptable manufacturers:
 - 1. O.Z./Gedney
 - 2. Crouse-Hinds
 - 3. Appleton

2.09 EXPANDABLE CONDUIT PLUGS

- A. Seal open underground telecommunications conduits entering the building with expandable conduit plugs with rope ties.
- B. Refer to drawings for underground entrance locations.
- C. Design Make: Osburn Associates or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install conduit in accordance with NECA "Standard of Installation".
- B. All conduit penetrations through fire-rated construction must be sealed with UL listed fire stopping. Refer to architectural drawings for locations.
- C. Size raceways as indicated on the drawings. Where sizes are not indicated, raceways shall be sized as required by the National Electrical Code in accordance with the quantity, size, type and insulation of conductors to be installed.
- D. Minimum 1/2" trade size for branch circuit and fire alarm wiring.
- E. Minimum 3/4" trade size for voice/data outlets, television outlets, and branch circuit "Home Runs" to panelboards.

- F. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25% additional conduits.
- G. Provide a code compliant ground path between all outlets and the established electrical system ground.
- H. Coordinate all raceway runs with other trades.
- I. Do not install raceways adjacent to hot surfaces or in wet areas. Maintain 12" clearance between conduit and surfaces with temperatures exceeding 104° F (40° C).
- J. Provide expansion fittings with external grounding straps at building expansion joints.
- K. Arrange neatly to permit access to the raceway, outlet, pull, and junction boxes, and work installed by other trades.
- L. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations.
- M. All exposed conduit mounted to a painted surface shall be painted to match that surface.
- N. No conduit shall be run in or through an Elevator Machine Room, hoistway or pit unless it contains circuitry specifically required for the elevator or elevator related equipment.
- O. No conduit shall be run in or through a Stairwell unless it contains circuitry specifically required for the Stairwell related equipment.
- P. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- Q. Provide at least one junction or pull box for each 360 degrees of bends.
- R. Provide green ground wire in all EMT, flexible conduit, and non-metallic conduit.

3.02 INSTALLATION

- A. Install raceways parallel or perpendicular to building walls, floors and ceilings.
- B. Cut raceways square, ream ends to remove burrs, and bush where necessary.
- C. Route conduit in and under slab from point to point. Do not cross conduits in slab. Provide U.L. approved rain-tight and concrete tight couplings and connectors. All conduit in concrete floor slabs shall be rigid galvanized steel with concrete tight threaded fittings. Install conduit below the reinforcing mesh. Locate conduits to provide a minimum of 1" of concrete around conduit. Obtain approval from the Owner's Representative prior to installing conduit larger than 1" trade size in concrete slabs.
- D. Install with a minimum of bends and offsets. Bends shall not kink or destroying the interior cross section of the raceway. Factory made bends shall be used for raceways 1" trade size and larger.
- E. Support raceways from building construction. Do not support raceways from ductwork, piping, or equipment hangers. Arrange supports to prevent misalignment during wiring installation. Support conduit using coated steel or malleable iron straps, lay in adjustable hangers, clevis hangers, and split hangers. Do not attach conduit to ceiling support wires. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

- F. Plug the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.
- G. Secure conduit within three feet of each outlet box, junction box, cabinet or fitting.
- H. Provide a #14 AWG fish wire in all "Spare" or "Empty" conduit runs to facilitate future installation of conductors.
- I. Provide expansion fittings where conduits cross building expansion joints.
- J. Wherever a cluster of (4) or more conduits rise out of floor exposed, provide neatly formed 4 in. high concrete envelope, with chamfered edges, around raceways.
- K. Provide 4 spare 3/4-in. raceways from each flush mounted panelboard or cabinet to an area above the nearest accessible ceiling space. Make 90° turn above the ceiling, arranged for further continuation of raceway, and cap.
- L. Join non-metallic conduit using cement as recommended by manufacturer. Wipe non-metallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- M. Where conduits puncture roof, install pitch pockets as required in order that the roof warranty is maintained.
- N. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Owner's Representative and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.
- O. Core drill, sleeve, and fire stop all penetrations through existing floors.
- P. In exterior or wet locations, provide minimum 1/4" air space between raceway and wall. Secure raceway within 3 ft. of each outlet box, junction box, cabinet or fitting.
- Q. Provide conduit supports based on the following table:

Conduit Trade Size	Type of Run	Horizontal Spacing in Feet	Vertical Spacing in Feet
1/2", 3/4"	Concealed	7	10
1", 1-1/4"	Concealed	8	10
1-1/2" & larger	Concealed	10	10
1/2", 3/4"	Exposed	5	7
1", 1-1/4"	Exposed	7	8
1-1/2" & larger	Exposed	10	10

- R. Conceal conduits in all locations except for mechanical and equipment rooms. Obtain owner's permission to run exposed conduits in other areas if existing conditions warrant exposed conduit.

3.03 REUSE OF EXISTING RACEWAYS

- A. Do not change number of raceways to less than the number indicated on the drawings except when appropriate for advantageous reuse of existing exposed and concealed raceways (the contract documents do not indicate location, number, size or condition of existing raceways).

- B. The existing raceway must be of adequate size for the new conductors to be installed therein (NFPA 70 Chapter 9, Tables 1, 4, & 5; Appendix C, Tables C1-C12a). More circuits may be enclosed by existing raceways than the circuiting shown on the drawings provided conductor sizes are increased to compensate for derating (adjustment factors) and other considerations required by NFPA 70 Article 310-15.
- C. Remove existing conductors.
- D. Demonstrate to the Director's Representative that the existing raceway is clear of obstructions and in good condition.
- E. Check ground continuity. When ground continuity of existing raceway is inadequate install insulated grounding bushings, grounding wedges, bonding straps, grounding jumpers or equipment grounding conductors to establish effective path to ground.
- F. Install insulated bushings to replace damaged or missing bushings. Replace non-insulated bushings with insulated bushings on raceway sizes 1 inch and larger.
- G. Install vertical conductor supports to replace existing or missing vertical conductor supports.
- H. Install extension rings on existing boxes when the number of new conductors installed therein exceeds NFPA 70 requirements.
- I. Furnish the Owners' Representative with marked up drawings showing size and routing of existing raceways with number and size of new conductors installed therein. The drawings will be forwarded to the design engineer for verification of NFPA 70 compliance.

3.04 RACEWAYS FOR FUTURE USE (SPARE RACEWAYS AND EMPTY RACEWAYS)

- A. Draw fish tape through raceways in the presence of the Owners Representative to show that the raceway is clear of obstructions. Leave a pulling-in line in each spare and empty raceway.

3.05 RACEWAY INSTALLATION - SPECIAL AREAS

- A. Raceways Exposed to Different Temperatures: Where portions of an interior raceway system are exposed to widely different temperatures, seal interior and exterior of raceway to prevent circulation of air from a warmer to a colder section through the raceway installation.
- B. Heated Areas to Unheated Areas: After conductors are installed, seal interior of the raceway at the nearest conduit body, outlet or junction box in the heated area adjoining the unheated area.
- C. Conduit in Waterproofed Floors: Install conduit runs in waterproof floors to avoid penetrating the waterproofing. Avoid penetration of waterproofing with conduit risers so far as practicable.
- D. Where it is necessary to puncture the waterproofing for a conduit riser, install a standard weight steel pipe sleeve extending one inch above the finished floor level. Flash the steel pipe sleeve to the waterproofing with 16-ounce copper. Construct the flashing with a copper tube extending the full height of the sleeve, soldered to a copper base extending 6 inches in all directions from the sleeve.
- E. The flashing will be integrated into the waterproofing by the Construction Contractor. Provide solid cast brass floor plates with chromium finish where pipe sleeves are exposed in rooms.
- F. Install sealing fittings in concealed conduit runs in a recessed box with blank face plate to match other face plates in the area.

3.06 RACEWAY SCHEDULE

A. Rigid Ferrous Metal Conduit

1. Exterior above grade
2. Transition elbows from above to below grade.
3. Where specifically called for on plans.

B. Electrical Metallic Tubing:

1. May be installed concealed as branch circuit conduits above suspended ceilings where conduit does not support fixtures or other equipment.
2. May be installed concealed as branch circuit conduits in hollow areas in dry locations, including:
 - a. Hollow concrete masonry units, except where cores are to be filled.
 - b. Drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.
3. May be installed exposed as branch circuit conduits in dry non-hazardous locations at elevations over 10'-0" above finished floor where conduit does not support fixtures or other equipment.

C. Flexible Metal Conduit: Install equipment grounding conductor in the flexible metal conduit and bond at each box or equipment to which conduit is connected:

1. Use for final conduit connection to recessed lighting fixtures in suspended ceilings. Use 4 to 6 feet of flexible metal conduit, minimum size 1/2 inch, between junction box and fixture. Locate junction box at least 1 foot from fixture and accessible if the fixture is removed.
2. Use 1 to 3 feet of flexible metal conduit for final conduit connection to:
 - a. Emergency lighting units.
 - b. Dry type transformers.
 - c. Motors with open, drip-proof or splash-proof housings.
 - d. Equipment subject to vibration (dry locations).
 - e. Equipment requiring flexible connection for adjustment or alignment (dry locations).
3. Use for concealed branch circuit conduits above existing non-removable suspended ceilings where rigid type raceways cannot be installed due to inaccessibility of space above ceiling.
4. May be installed concealed as branch circuit conduits in drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.

D. Liquid-tight Flexible Metal Conduit: Install equipment grounding conductor in liquid-tight flexible metal conduit and bond at each box or equipment to which conduit is connected:

1. Use 1 to 3 feet of liquid-tight flexible metal conduit (UL listed and marked suitable for the installation's temperature and environmental conditions) for final conduit connection to:
 - a. Motors with weather-protected or totally enclosed housings.
 - b. Equipment subject to vibration (damp and wet locations).
 - c. Equipment requiring flexible connection for adjustment or alignment (damp and wet locations).

E. Rigid Nonmetallic PVC Conduit:

1. Schedule 80:
 - a. Exterior underground
 - b. Exterior above ground only when specifically noted on plans.

3.07 FITTINGS AND ACCESSORIES SCHEDULE

A. General:

1. Use fittings and accessories that have a temperature rating equal to, or higher than the temperature rating of the conductors to be installed within the raceway.
2. Use zinc electroplate or hot dipped galvanized steel/malleable iron or cast iron alloy fittings and accessories in conjunction with ferrous raceways in dry and damp locations unless otherwise specified or indicated on the drawings.
3. Use insulated grounding bushings or grounding wedges on ends of conduit for terminating and bonding equipment grounding conductors, when required, if cabinet or boxes are not equipped with grounding/bonding screws or lugs.
4. Use caps or plugs to seal ends of conduits until wiring is installed to exclude foreign material.
5. Use insulated grounding bushings on the ends of conduits that are not directly connected to the enclosure, such as stub-ups under equipment, etc., and bond between bushings and enclosure with equipment grounding conductor.
6. Use expansion fittings where raceways cross expansion joints (exposed, concealed, buried).
7. Use deflection fittings where raceways cross expansion joints that move in more than one plane.
8. Use 2 locknuts and an insulated bushing on end of each conduit entering sheet metal cabinet or box in dry or damp locations.
9. Plastic bushing may be used on 1/2 and 3/4-inch conduit in lieu of insulated bushing.
10. Terminate conduit ends within cabinet/box at the same level.

B. For Rigid and Intermediate Metal Conduit: Use threaded fittings and accessories. Use 3-piece conduit coupling where neither piece of conduit can be rotated.

C. For Electrical Metallic Tubing: Use compression type connectors and couplings.

D. For Flexible Metal Conduit: Use flexible metal conduit connectors.

E. For Liquid-tight Flexible Metal Conduit: Use liquid-tight connectors.

F. For Rigid Nonmetallic PVC Conduit: Use conduit manufacturer's standard fittings and accessories.

END OF SECTION 26 0533

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

- A. Surface metal raceways.
- B. Wireways.

1.03 REFERENCES

- A. NECA (National Electrical Contractors Association) Standard of Installation.
- B. NEMA WD 6 - Wiring Device Configurations.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with NECA Standard of Installation.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum (3) years' experience.

PART 2 - PRODUCTS

2.01 SURFACE METALLIC RACEWAY

- A. Multiple Communications or Branch Circuits (Medium Capacity):
 - 1. 0.82" H x 1.9"W.
 - 2. Metallic two piece raceway with single compartment.
 - 3. Color shall be Ivory color durable finish scratch-resistant surface that can be painted.
 - 4. Provide the following fittings as required for installation:
 - a. Entrance End Fitting: nominal maximum dimensions of 2.75"W x 2.75"H x 4"L and 1.5" or 1.25" conduit opening
 - b. Back Entrance End Fitting: same as entrance end fitting with internal radius.
 - c. T fittings.
 - d. Bridge fitting with radius for spanning existing raceways in varying widths from 1/2" to 4.
 - e. Flat internal and external elbows UL verified for a 2" bend radius and exceeding the recommendations of EIA/TIA 569A.
 - 5. Design Make: Mono-Systems SMS2400 series raceway, SMS2457 series bridge fittings, SMS2410 series entrance end fittings, SMS 2442 and 2430 T fittings.

6. Acceptable Manufacturers:
 - a. Mono-Systems SMS2400 Series.
 - b. Wiremold 2400 Series.
- B. Combination Power and Data Cables:
1. 1.75" H x 4.75"W.
 2. Metallic two piece raceway with single or split compartment as called for on plans.
 3. Color shall be Ivory color durable finish scratch-resistant surface that can be painted.
 4. Provide the following fittings:
 - a. Entrance End Fitting: nominal maximum dimensions of 4.75"W x 3"H x 4"L and 2.5" or 2" conduit openings
 - b. Back Entrance End Fitting: same as entrance end fitting with internal radius.
 - c. T fittings.
 - d. Flat internal and external elbows with fiber optic radius.
 5. Design Make: Mono-Systems SMS4200 series raceway, with SMS4205 SMS4214FO, SMS4211FO and SMS4209FO fittings
 6. Acceptable Manufacturers:
 - a. Mono-Systems SMS4200 Series.
 - b. Wiremold 4000 Series.
- C. Single Branch Circuit or Data Cable
1. One-piece raceway
 2. Color shall be Ivory
 3. Utilized for wall mounted phones and miscellaneous branch circuit power only.
 4. Provide internal and external 90 degree fittings with radius.
 5. Design Make: Mono Systems SMS700
 6. Acceptable Manufacturers:
 - a. Mono-Systems SMS700 Series.
 - b. Wiremold 700 Series.
- D. Provide miscellaneous boxes, extension rings, fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.

2.02 MULTI-OUTLET ASSEMBLY

- A. Sheet metal channel with fitted cover, with pre-wired receptacles, suitable for use as multi-outlet assembly.
- B. Size: 1.28" x 0.75".
- C. Receptacles: NEMA WD 6, type 5-15R, single receptacle.
- D. Receptacle Spacing: As indicated on the drawings.
- E. Receptacle Color: Ivory.
- F. Channel Color: Ivory enamel.
- G. Fittings: Furnish manufacturer's standard couplings, elbows, and connectors.
- H. Design Make: Wiremold 2000.

2.03 WIREWAY

- A. Manufacturers:
 - 1. Square D.
 - 2. Substitutions: Refer to Division 1.
- B. Description: General purpose, Oil-tight, dust-tight, and Rain-tight type wireway.
- C. Knockouts: Manufacturer's standard.
- D. Size: As indicated on Drawings.
- E. Cover: Hinged cover.
- F. Connector: Flanged.
- G. Fittings: Lay-in type with removable top, bottom, and side; captive screws.
- H. Finish: Rust inhibiting primer coating with gray enamel finish.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Support with expansion anchors, concrete inserts, masonry inserts or toggle bolts as field conditions require. Provide supports at five foot centers.
- B. Install a separate green ground conductor in raceway from the junction box where surface raceway begins to the ground terminal of the device, fixture or equipment being supplied.
- C. Provide all fittings, connectors, elbows, tees, boxes etc. as required for the installation.
- D. Raceway shall be factory painted. Touch up raceway and outlet boxes as required upon completion of installation.
- E. Provide new covers and device brackets in areas where existing raceway is called for reuse. Paint raceway to match existing upon completion.
- F. Provide all required conduit entrance end fittings and elbows required for a complete installation.
- G. Raceway shown on plans is diagrammatical only. Route raceway around existing room features as required.
- H. Where existing conduits, pipes and other obstacles interfere with the installation of new raceway at 90 degree angles, provide bridge fittings to traverse the obstacle without rerouting. If this is not possible reroute the surface raceway or the existing raceway as directed by owners' representative.
- I. Install Products in accordance with manufacturer's instructions.
- J. Use flat-head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level. This shall be done for WM400BAC as well, even though raceway comes with adhesive.
- K. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- L. Wireway Supports: Provide steel channel as specified in section 260190.
- M. Close ends of wireway and unused conduit openings.
- N. Ground and bond under provisions of section 260526.

END OF SECTION 26 0534

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

- A. Electrical connections to equipment.

1.03 REFERENCES

- A. NEMA WD 1 - General Purpose Wiring Devices.
- B. NEMA WD 6 - Wiring Devices - Dimensional Requirements.
- C. NFPA 70 - National Electrical Code.

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.05 COORDINATION

- A. Refer to Division 1.
- B. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- C. Determine connection locations and requirements.
- D. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- E. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 - PRODUCTS

2.01 ELECTRIC CORDS

- A. Provide multi-conductor SO cords, comprised of 2 or more conductors. Type SJEOOW or Type SEOOW flexible cords manufactured using bare flexible stranded Class K copper conductors, and heat, moisture and oil resistant thermoplastic-elastomer (TPE) insulation. The insulated conductors shall be cabled with non-wicking polypropylene fillers, with a tissue-paper separator wrapped around the assembly for easier removal. A heat, moisture and oil resistant flexible TPE jacket is extruded over the assembly.
- B. Type SJEOOW 300 Volt and type SEOOW 600 Volt flexible cords are permitted for use as specified by Article 400 and related articles of the National Electrical Code.

- C. Typical applications include:
1. Industrial Machinery.
 2. Large Appliances.
 3. Motors.
 4. Temporary power.
- D. Suitable for use in:
1. Dry locations not to exceed minimum -50°C (-58°F) or maximum 105°C (221°F).
 2. Wet locations or other applicable locations.
 3. S type cords may be completely immersed in water, or exposed to oil or coolant at temperatures not to exceed 60°C (140°F).
- E. Acceptable Manufacturers:
1. Allied Wire.
 2. WesBell.
 3. Consolidated electronic wire and cable.

2.02 PLUG CAPS, CONNECTORS AND SWITCHES

- A. Provide twist lock type plugs and receptacles when used for connecting equipment with fabricated SO cord connection.
- B. Provide the following as project conditions require.
1. Standard 20 and 30 Amp Plugs and Connectors:
 - a. Two-part cord grip tightens with two screws for maximum retention force. Broad gripping area to accommodate wide range of cable diameters.
 - b. Tough ribbed nylon housing for secure gripping.
 - c. Insulated nylon construction to keep non-current carrying parts from becoming energized.
 - d. Self-threading screws specially designed for secure assembly.
 - e. Wiring chambers separate and positively insulate conductors and promote easy inspection.
 - f. Integral dust shield protects wiring chamber from dust or contaminants. Single-piece shield/housing eliminates need for separate step at installation.
 - g. Design Make: Hubbell HBL2311 plug and HBL2313 receptacle.
 2. Standard Receptacle:
 - a. High-impact, abuse-resistant nylon face.
 - b. All-brass mounting and grounding system provides a lower resistance ground path and greater resistance to corrosion than steel mounting systems.
 - c. Glass-Reinforced thermoplastic polyester base (RTP) has the desirable characteristics of a thermoset material, including heat, flame resistance and dimensional stability.
 - d. One-piece contact with long spring arm (low stress) and oxide cutting nibs: prevents stress and overheating associated with riveted contact and short spring arms.
 - e. #10 silicon bronze terminal screw provides greater strength and resistance to corrosion and stripping. Anti-rotational clamp has a stop to limit the amount of cocking when only one side is used. Accommodates both back and side wiring.
 - f. Wire restraint recess for both back and side wiring, greatly reduces the possibility of loosening the terminal connection.

- g. Design Make: Hubbell HBL2310.
- 3. Mechanical Interlock Switched Safety Enclosures:
 - a. Lockable handle provides lockout protection for greater safety and complies with OSHA lockout requirements.
 - b. Horsepower rated switch.
 - c. Angled 20 or 30 amp water tight Twist-Lock receptacle.
 - d. Heavy-duty interlock linkage prevents make and break under load.
 - e. Moveable feet may be used in horizontal or vertical position or may be removed and pre-marked holes drilled for Type 1 or 3R installations.
 - f. Heavy-duty internal frame bonds conduit and all grounds and has a DIN rail to accommodate the switch.
 - g. Pre-molded conduit entry hole is offset to prevent water condensation from falling directly on interior electrical components.
 - h. Design Make: Hubbell HBLMITL.
- 4. 50 Ampere Plugs and Connector Bodies:
 - a. Stainless steel shroud restricts mis-mating with the wrong device.
 - b. Thermoplastic polyester interior provides heat resistance and impact strength.
 - c. Housing assembly latch slotted to fit standard flat-blade screwdriver.
 - d. Padlock capable shroud allows compliance to OSHA lockout tag out regulation 29 CFR 1910.147.
 - e. Three-piece thermoplastic clamp assembly with stainless steel fast lead screws provides a more consistent, durable grip. Sealed cable entry keeps out moisture and dust.
 - f. 6/6 nylon nose - thermoplastic polyester terminal cover provides heat resistance in terminal area and impact strength of nose piece.
 - g. One-piece grounding contact on 4-wire devices provides a more reliable grounding system.

C. Acceptable Manufacturers:

- 1. Hubbell
- 2. Legrand
- 3. Leviton

2.03 DISCONNECT SWITCHES, MOTOR CONTROLS AND ENCLOSED CIRCUIT BREAKERS

- A. Provide fused or Non-fused disconnects as called for on drawings.
- B. Where motor controls are furnished by others and not located within sight of the equipment provide a non fused disconnect at the equipment.
- C. Provide motor controls as called for on the electric equipment control schedule.
- D. Provide KAIC ratings equivalent to the panel or switchboard feeding the electrical equipment.
- E. Refer to Specification Section 262400 for technical specifications.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 BREAKERS FOR EQUIPMENT FURNISHED BY OTHERS

- A. Where equipment or motors are furnished by others field verify the exact breaker and wiring requirements prior to installation. Upsize breakers and wiring within the same breaker frame at no additional cost to the contract if required.
- B. Provide breakers with KAIC rating equivalent to the panel or switch board.

3.03 DISCONNECTS

- A. Unless a disconnect is specifically called out on mechanical/HVAC drawings provide a lockable disconnect for all rooftop equipment. Disconnect shall be located within sight of the equipment. Provide fused disconnects where called for.
- B. Provide disconnects for ahead of VFDs furnished by the mechanical contractor.
- C. Provide mounting hardware and unistrut for installation of disconnects.
- D. Provide all power wiring from disconnect to motors.

3.04 MOTOR CONTROLS

- A. Install motor controls furnished by mechanical contractor or provide motor controls as called for in the electric equipment control schedule.
- B. For indoor equipment mount controls within sight of equipment.
- C. Where controls are not packaged with equipment locate as approved by the engineer and construction manager.
- D. For rooftop equipment install controls indoors in electrical, mechanical or storage room.
- E. Provide all wiring and raceways from the control equipment to the motor.
- F. Gang controls for multiple motors where practical.

3.05 ELECTRICAL CONNECTIONS

- A. Provide complete power connections to all electrical equipment. Provide control connections to equipment where indicated on the drawings. Provide disconnect ahead of each piece of equipment. Ground all equipment in accordance with the latest version of the National Electrical Code.
- B. Provide all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required for proper equipment operation of Owner-Furnished Equipment and Equipment furnished by other contracts.
- C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements prior to roughing.
- D. Make electrical connections in accordance with equipment manufacturer's instructions.
- E. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.

- F. Connect heat-producing equipment using wire and cable with insulation suitable for temperatures encountered.
- G. Provide receptacle outlet to accommodate connection with attachment plug.
- H. Provide cord and cap where field-supplied attachment plug is required.
- I. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- J. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- K. Install terminal block jumpers to complete equipment wiring requirements.
- L. Install control devices furnished by others.
- M. Provide control devices as called for on electric equipment control schedule.
- N. Coordinate all work with other contractors and the manufacturers who are furnishing equipment and controls.
- O. Where drawings call for controllers to be mounted remote from the equipment provide non-fused disconnect switch at the unit.
- P. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION 26 0536

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 WORK INCLUDES

- A. Wall and ceiling outlet boxes.
- B. Pull and junction boxes.
- C. Floor boxes.
- D. Poke through boxes.

1.03 REFERENCES

- A. NECA - Standard of Installation.
- B. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
- C. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- D. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. NFPA 70 - National Electrical Code.

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Provide Products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.05 SUBMITTALS FOR REVIEW

- A. Provide Product Data for the following:
 - 1. Floor Boxes

PART 2 - PRODUCTS

2.01 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel. Not less than 1-1/2" deep, 4" square or octagonal, with knockouts. Outlet boxes exposed to moisture, exterior, wet or damp locations shall be cadmium cast alloy complete with threaded hubs and gasketed screw fastened covers. Minimum box size shall be as indicated in Article 314 of the National Electrical Code for the conductors and devices installed. Boxes shall be approved for the environmental condition of the location where they will be installed.
- B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2" male fixture studs where required.

C. Acceptable manufacturers:

1. Steel City
2. Raco
3. Appleton
4. Crouse Hinds

2.02 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel. Shall be constructed of not less than 14 gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type covers. Boxes installed in damp or wet locations shall be of raintight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

2.03 TERMINAL AND EQUIPMENT CABINETS IN NON HAZERDOUS LOCATIONS

- A. Steel Equipment Cabinets shall be code gauge galvanized steel with removable end walls. Fronts shall be of code gauge steel, flush or surface type (as indicated) with concealed trim clamps, concealed hinges, flush lock, and grey baked enamel finish. Boxes and front shall be U.L. listed and shall be minimum 24"H x 24"W x 6"D or as called for on plans. Provide provisions for terminal board mounted on inside back wall of cabinet as required.
- B. Fiber glass equipment cabinets shall be Compression-molded fiberglass for chemical and temperature-resistance. Gasketed for water-tight and dust-tight seal. Polyester mounting brackets and stainless steel attachment screws, molded-in-place threaded brass inserts and plated steel screws for mounting optional panels and terminal block kits. Removable hinged cover attached to body with Type 316 stainless steel hinge pin or Screw-cover enclosure secured with two captivated Type 316 stainless steel slotted cover screws.
- C. Stainless Steel terminal and equipment cabinets shall have continuous hinge, seamless foam-in-place gasket and stainless steel screw-down clamps for a reliable seal that protects components from corrosive environments. 14-gauge Type 304 stainless steel with seams continuously welded and ground smooth, seamless foam-in-place gasket. Weld nuts for mounting optional panels and terminal block kits. Provide bonding provision on door and body.
- D. Poly carbonate boxes shall be non-glass-filled polyester material offers superior UV resistance. Chemical resistance to a broad range of solvents, alkalis and acids. Crack and impact resistant. Shall be recyclable.
- E. Provide following accessories and options where called for.
1. Continuous hinged door (unless otherwise noted provide screw type covers).
 2. Scratch-resistant polycarbonate windows permanently bonded in place.
 3. Quick-release latches and corrosion-resistant polyester latches located in corners that provide unobstructed access to enclosure.
 4. Padlock provisions in latch.

F. Provide the NEMA type listed below as required for the environment and use:

1. Type 1: for indoor use to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt).
2. Type 3R: for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.
3. Type 4X: for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); that provides an additional level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.
4. Type 12: for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

G. Acceptable Manufacturers:

1. Hoffman
2. Thomas & Betts
3. Wiegmann
4. Appleton

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify locations of boxes and outlets prior to rough in. Thoroughly examine the architectural elevations and millwork shop drawings.
- B. If outlets are not specifically shown on elevations and there is millwork or equipment associated with the outlets issue an RFI prior to rough in.

3.02 ENCLOSURE RATINGS AND LOCATIONS

- A. Provide NEMA Ratings as required for specific application. Submit specific NEAM Ratings proposed with electrical equipment, panelboard, device and motor control submittals.

NEMA RATING	LOCATIONS
1	General-purpose indoors and under normal atmospheric conditions.
2	Drip-tight. Similar to Type 1 but with addition of drip shields; used where condensation may be severe such as in cooling and laundry rooms
3	Weather-resistant. Protects against falling dirt and windblown dust, against weather hazards such as rain, sleet and snow, and is undamaged by the formation of ice. Used outdoors on ship docks, in construction work, and in tunnels and subways.
3R	As 3, but <i>omits</i> protection against windblown dust. Utilize for exterior and rooftop locations
3S	As 3, but also operable when laden with ice. Utilize for motor controls located of rooftops or exterior walls subject to snow cover.
4 and 4X	Watertight. Must exclude at least 65 GPM of water from a 1 in nozzle delivered from a distance not less than 10 ft for 5 min. Use outdoors on ship docks, in dairies, in wastewater treatment plants and breweries. X indicates additional corrosion resistance. Provide 4X where specifically called for on plans.
5	Dust-tight. Provided with gaskets or equivalent to exclude dust; use in steel mills and cement plants.
6 and 6P	Submersible. Design depends on specified conditions of pressure and time; submersible in water or oil; used in quarries, mines, and manholes. 6 is temporarily submersible, 6P withstands occasional prolonged submersion. Neither are intended for continuous submersion.
7	Certified and labelled for use in areas with specific hazardous conditions: for indoor use in Class I, Groups A, B, C, and D environments as defined in NFPA standards such as the NEC.
8	Certified and labeled for use in areas with specific hazardous conditions: for indoor and outdoor use in locations classified as Class I, Groups A, B, C, and D as defined in NFPA standards such as the NFPA 70.
9	Certified and labelled for use in areas with specific hazardous conditions: for indoor and outdoor use in locations classified as Class II, Groups E, F, or G as defined in NFPA standards such as the NEC.
10	MSHA. Meets the requirements of the Mine Safety and Health Administration, 30 CFR Part 18 (1978).
11	General-purpose. Protects against the corrosive effects of liquids and gases. Meets drip and corrosion-resistance tests.
12 and 12K	General-purpose. Intended for indoor use, provides some protection against dust, falling dirt, and dripping non-corrosive liquids. Meets drip, dust, and rust resistance tests.
13	General-purpose. Primarily used to provide protection against dust, spraying of water and non-corrosive coolants. Meets oil exclusion and rust resistance design tests

3.03 INSTALLATION

- A. Install boxes in accordance with NECA "Standard of Installation."
- B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements. Install junction and pull boxes in readily accessible locations. Access to boxes shall not be blocked by equipment, piping, ducts and the like. Provide all necessary junction or pull boxes required due to field conditions and size as required by the National Electrical Code.

- C. Consider location of outlets shown on drawings as approximate only. Study architectural, process piping, mechanical, plumbing, structural, roughing-in, etc., drawings and note surrounding areas in which each outlet is to be located. Locate outlet so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet will serve its desired purpose. Where conflicts are noted between drawings, contact Owner's Representative for decision prior to installation. Comply with Article 314 of National Electrical Code relative to position of outlet boxes in finished ceilings and walls. Adjust box location up to 10 feet if required to accommodate intended purpose.
- D. Orient boxes to accommodate wiring devices oriented as specified in Section 262726
- E. Maintain headroom and present neat mechanical appearance.
- F. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- G. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 1.
- H. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- I. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- J. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- K. Do not install flush mounting box back to back in walls; provide minimum 6" separation.
- L. Do not fasten boxes to ceiling support wires.
- M. Support boxes independently of conduit.
- N. Outlet boxes installed in plaster, gypsum board or wood paneled walls shall be installed with raised plaster covers or raised tile covers. Use gang box where more than one device is mounted together. Do not use sectional box.
- O. Use gang box with plaster ring for single device outlets.
- P. Use cast outlet box in exterior locations exposed to the weather and wet locations.
- Q. Outlet boxes shall be sized to accommodate the wiring device(s) to be installed.
- R. Outlet boxes installed in tile, brick or concrete block walls shall be installed with extra-deep type raised tile covers or shall be 3-1/2" deep boxes with square corners and dimensions to accommodate conductors installed.
- S. Surface ceiling mounted outlet boxes shall be minimum 4" square, 1-1/2" deep, galvanized sheet metal.
- T. Surface wall mounted outlet boxes shall be cast type boxes having threaded or compression type threadless hubs. Exterior boxes shall be cast type with threaded hubs and gasketed cover plates secured by non-ferrous screws.

- U. Floor outlet boxes shall be installed flush with finished floor, adjust level and tilt as required. Where finished floor is terrazzo, provide boxes specifically designed for installation in terrazzo. Where floors are to receive carpet, provide floor outlet with carpet flange.
- V. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment centerline as follows:

1. Toggle switches	46"
2. Receptacle outlets (outside resident rooms)	18"
3. Receptacles and communication outlets in resident rooms	24"
4. Do not install receptacle outlets above electric baseboard heaters.	30"
5. Receptacle outlets, hazardous areas	48"
6. Receptacle outlets, weatherproof, above-grade	24"
7. Clock outlets	90"
8. Telephone outlets	18"
9. Telephone outlets, wall mounted	46"
10. T.V. outlet	78"
11. Fire alarm manual station	46"
12. Fire alarm audio/visual	80"
13. Branch circuit panelboards, to top of backbox	72"
14. Distribution panelboards, to top of backbox	72"
15. Terminal cabinets, control cabinets	72"
16. Disconnect switches, motor starters, enclosed circuit breakers	48"
17. Where structural or other interferences prevent compliance with mounting heights listed above, consult Owner's Representative for approval to change location before installation.	

3.04 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate installation and location of outlet box for equipment with equipment supplier and other trades as applicable.
- B. Cut boxes in millwork using methods approve by manufacturer and architect.

3.05 ADJUSTING

- A. Adjust flush mounting outlets to make front flush with finished wall material.
- B. Adjust vertical and horizontal alignment of boxes as required.
- C. Install knockout closures in unused box openings.

3.06 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

END OF SECTION 26 0540

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

- A. Circuit Breakers.
- B. Switchboards.
- C. Distribution Panelboards.
- D. Branch Circuit Panelboards.
- E. Retrofit Panelboards.
- F. Transient Voltage Surge Suppression.
- G. Power Monitor.
- H. Disconnect Switches.
- I. Enclosed Circuit Breakers.
- J. Low Voltage Fuses.
- K. Sub-Metering Hardware and Software

1.03 REFERENCES

- A. The equipment referenced herein are designed and manufactured according to the following appropriate specifications.
 - 1. ANSI/NFPA70 - National Electric Code (NEC).
 - 2. ANSI/IEEE C12.1 - Code for Electricity Metering.
 - 3. ANSI C39.1 - Electrical Analog Indicating Instruments.
 - 4. ANSI C57.13 - Instrument Transformers.
 - 5. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 6. NEMA KS 1 - Enclosed Switches.
 - 7. NEMA PB 2 - Deadfront Distribution Switchboards, File E8681.
 - 8. NEMA PB 2.1 - Proper Handling, Installation, Operation & Maintenance of Deadfront Switchboards Rated 600V or Less.
 - 9. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.
 - 10. UL 50 - Cabinets and Boxes.
 - 11. UL 98 - Enclosed and Dead front Switches.
 - 12. UL 489 - Molded Case Circuit Breakers.
 - 13. UL 891 - Dead Front Switchboards.
 - 14. UL 943 - Ground Fault Circuit Interrupters.
 - 15. UL 1053 - Ground Fault Sensing and Relaying Equipment.
 - 16. UL 977 - Fused Power Circuit Devices.
 - 17. CSA 22.2 No. 5 - M1986 Molded Case Circuit Breakers.
 - 18. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit and Service.
 - 19. Federal Specification W-C-870 - Fuse holders (for plug and enclosed cartridge fuses).
 - 20. Federal Specification W-S-865 - Enclosed Knife Switch.
 - 21. NECA Standard of Installation (published by the National Electrical Contractors Association).
 - 22. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

23. NFPA 70 - National Electrical Code.

1.04 SUBMITTAL FOR REVIEW

- A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.
- B. Prior to releasing the service switchgear equipment verify the tenant service requirements with the construction manager and owner. Do not release the switch gear for fabrication until receiving written permission from the owner.

1.05 SUBMITTALS FOR CLOSEOUT

- A. Maintenance Data: Include spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum (10) years' experience.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products in conformance with manufacturer's recommended practices as outline in applicable Installation and Maintenance Manuals.
- B. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.
- C. Inspect and report concealed damage to carrier within their required time period.
- D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.01 CIRCUIT BREAKERS

- A. General:
 - 1. Molded case circuit breakers shall be constructed of a glass reinforced insulating material. All current carrying components shall be completely insulated and isolated from the outside of the circuit breaker.
 - 2. Provide an over-center, trip-free handle to provide quick-make, quick-break contact action.
 - 3. Provide multi-pole breakers with common trip.

4. When the circuit breaker has tripped, the handle shall move to a position between the "on" and "off" positions. Provide a visual indication that the circuit breaker has tripped.
5. The ampere rating shall be clearly marked on the face of the circuit breaker.
6. Any series rated fuse/circuit breaker installations shall be UL listed as recognized component combinations. Provide a label at the Series rated device reading "Caution - Series Rated System. _____A available". Provide identical replacement of equipment".
7. Make provisions to add circuit breaker handle locks.
8. Circuit breakers shall have voltage, ampere, and interrupting ratings as called for on the Panelboard Schedule.

B. Thermal Magnetic Molded Case Branch Circuit Breakers:

1. Permanent trip unit containing individual thermal and magnetic trip elements.
2. Thermal trip unit shall be long time, non-adjustable, thermal overload trip.
3. Magnetic trip unit shall be instantaneous, electro-magnetic trip. Magnetic trip unit shall be adjustable for all frame sizes 225 amperes and larger.
4. Interchangeable rating plugs shall be provided for all frame sizes 400 amperes and larger.
5. 60°C terminal temperature rating for circuit breakers rated 125 amperes or below.
6. 75°C terminal temperature rating for circuit breakers rated above 125 amperes.
7. All 20 and 30 ampere, single pole circuit breakers shall be UL listed for switching duty.
8. Circuit breakers shall be plug-on [bolt-on]. I-Line type distribution circuit breakers are acceptable.
9. Circuit breakers rated 250 amperes and below shall be UL listed HACR type.
10. Where ground fault circuit breakers are required, provide a shunt trip circuit breaker with a zero sequence sensing ground fault module.
11. Acceptable Manufacturers:
 - a. Eaton
 - b. Square D.
 - c. General Electric.
 - d. Siemens ITE.

2.10 DISCONNECT SWITCHES

- A. Three pole, single throw, or as called for on the drawings.
- B. Quick-make, quick-break switch operating mechanism.
- C. Heavy-duty, current rating as called for on the drawings, voltage rating as required by the equipment served.
- D. All current carrying parts shall be plated to resist corrosion.

- E. Lugs shall be removable and rated for 75°C temperature rating.
- F. Switch blades shall be visible when the switch is in the open position and the door is open
- G. Switch shall be padlockable in the OFF and ON positions.
- H. Provide fusible switches with rejection type fuse holders and fuses as indicated on the plans or as per fed equipment requirements.
- I. Provisions for a field installable electrical interlock.
- J. Provide external override mechanism to open the disconnect switch door without opening the disconnect switch.
- K. Enclosure shall be steel with gray baked enamel paint.
- L. Provide NEMA type enclosures as called for on the drawings.
- M. NEMA type 1 enclosures shall be equipped with knockouts.
- N. Acceptable Manufacturers:
 - 1. Eaton
 - 2. Square D.
 - 3. General Electric.
 - 4. Siemens ITE.

2.11 LOW VOLTAGE FUSES

- A. All fuses rated 600 volts and below shall be rejection type dual-element, time-delay type. Provide (1) complete set(s) of fuses for all fusible disconnect switches, plus (3) spare fuses of each size. Deliver spare fuses to the Owner and obtain receipt.
- B. Acceptable manufacturers: Fuses 600 amperes and below: Bussman Type FRN-R (300 volts), Type FRS-R (600 volts) or equivalent.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install equipment to coordinate with installation details of other equipment associated with the power distribution system.
- B. Provide miscellaneous bolts, washers, nuts, clips, lock washers, small hardware, etc., of durium or equal rust resistant material, to make a complete installation.
- C. Provide complete installation in strict accordance with the equipment manufacturer's instructions, drawings and recommendations and as called for.
- D. In the event of conflict, discrepancy or difference between manufacturer's instructions and Contract Documents, the more stringent requirements shall apply.
- E. Unload, move, handle, set in place, install, erect, assemble, connect, test, and operate, etc. all items of electrical equipment as required.
- F. Provide rigging to unload, move, transport, set in place, erect, etc. the switchboards.
- G. Provide grounding as called for.
- H. Provide minimum working clearance as described in NEC Article 110-26 and 110-34 for all electric equipment.

- I. Provide additional working or aisle clearance as called for.
- J. Verify cable/lug sizes for terminations. Where a feeder is sized larger than the lug, provide in-line splice to reduce conductor size to match equipment or breaker terminations.
- K. Provide conduit lengths and types, equipment information and breaker information to the engineer after rough in is complete. The engineer will provide a coordination study and proper breaker settings,

3.02 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.4 for switches, and Section 7.5 for circuit breakers.

3.03 ADJUSTING

- A. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION 26 2400

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles.
- C. Cover plates.
- D. Occupancy Sensors.

1.03 REFERENCES

- A. NECA - Standard of Installation.
- B. NEMA WD 1 - General Requirements for Wiring Devices.
- C. NEMA WD 6 - Wiring Device - Dimensional Requirements.
- D. NFPA 70 - National Electrical Code.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum (3) years' experience.

1.05 COORDINATION

- A. The contractor and lighting fixture manufacturer are responsible for coordinating and guaranteeing that the driver/ballast dimmer combination will dim the driver or ballast to 1% or 10% as applicable. Utilize design make or acceptable manufacturers where possible. Provide equivalent devices from alternate manufacturers where required.

1.06 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Provide Products listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Color of devices shall be as selected by the Architect.
- B. Receptacles connected to emergency circuits must be Red
- C. Where devices are added to existing facilities the color shall match other existing devices in the room or vicinity.
- D. All devices must be specification grade at a minimum.
- E. Where devices are ganged together provide multi-device cover plates configured as required.
- F. Design Makes are from Pass & Seymour. Equivalent products from the following manufacturers are acceptable.
 - 1. Hubbell.
 - 2. Leviton.
 - 3. Lutron.

2.02 SPECIFICATION GRADE SWITCHES

- A. Specification Grade one-piece brass alloy contact arm for reliable electrical performance.
- B. One-piece steel strap with integral ground is plated for corrosion resistance.
- C. High strength thermoplastic polycarbonate toggle resists breaking and chipping under heavy abuse.
- D. Heavy-duty toggle bumpers for smooth and quiet operation.
- E. Back body made of glass-reinforced nylon.
- F. Locking support provides resistance to face and back body separation.
- G. Available with side wire or external screw-pressure-plate back and side wire models capable of accepting #14 - #10 AWG copper or copper-clad wire.
- H. Cam designed for fast make with positive break action to minimize arcing and prolong switch life.
- I. Oversized silver alloy contacts for longer dependable switch life.
- J. Provide double pole, single pole, three way or four way as called for or required.
- K. 120/277V, 20 Ampere rated.
- L. Design Make: Pass and Seymour CSB series.

2.03 KEY SWITCHES

- A. 120-277 VAC, 20 ampere rated.
- B. Locking type. Provide (1) key per switch, all keyed alike.
- C. Side or back wired.
- D. Quiet operation with key removable in both positions.
- E. Single pole, three-way, and four way as called for on the plans.
- F. Design Make: Pass & Seymour PS20AC series.

2.04 MOMENTARY SWITCHES

- A. 120-277 VAC, 20 ampere rated.
- B. Momentary contact.
- C. 2 circuit, 3 position, "center off".
- D. Side wired.
- E. Quiet operation.
- F. Color as selected by the architect.
- G. Design Make: Pass & Seymour TM811DTMO.

2.05 DIMMERS

- A. Two Wire Fluorescent or LED:
 - 1. For use with 2 wire 120V and 277V dimming ballasts and drivers.
 - 2. Field configurable wall plate system.
 - 3. Labeling system.
 - 4. Adjustable low end output voltage.
 - 5. Minimum of de-rating when ganged.
 - 6. Single pole slide-to-OFF or single pole/3-way as required.
 - 7. 1200 Watt rating.
 - 8. Design Make: CDFB10 Series.
- B. Four Wire Fluorescent and LED:
 - 1. For use with 0-10V, 4 wire, 120V and 277V dimming ballasts and drivers.
 - 2. Field configurable wall plate system.
 - 3. Labeling system.
 - 4. Adjustable low end output voltage.
 - 5. Rugged construction.
 - 6. Minimum of de-rating when ganged.
 - 7. Provide with power pack.
 - 8. Single pole slide-to-OFF and single pole/3-way as required.
 - 9. Design Make: Pass & Seymour CD4FB Series.
- C. Three Wire Fluorescent and LED:
 - 1. For use with 3 wire 120V and 277V dimming ballasts and drivers.
 - 2. Field configurable wall plate system.
 - 3. Labeling system.
 - 4. Adjustable low end output voltage.
 - 5. Rugged construction.
 - 6. Minimum of de-rating when ganged.
 - 7. Single pole slide-to-OFF and single pole/3-way preset models.
 - 8. Design Make: Pass & Seymour CD3FB10 series.

2.06 OCCUPANCY SENSORS

- A. Ceiling Mounted Sensors:
 - 1. Advanced signal processing circuitry helps to eliminate false ONs.
 - 2. Utilizes advanced, omni-directional (360 degrees), Doppler technology for reliable occupancy detection.

3. Angled transmitter and receiver pairs help optimize sensitivity while eliminating unwanted detection from ceiling air movement.
4. Digital DIP switch time delay (15 seconds to 30 minutes).
5. LED indicates occupancy detection.
6. Reliable solid-state construction.
7. Temperature and humidity resistant 32 kHz receivers.
8. Mounts to ceiling tiles or box.
9. Units per power pack: up to 4.
10. UL listed.
11. 5-year warranty.
12. Design Make: Pass & Seymour;
 - a. CSU600 (rooms less 500 square feet).
 - b. CSU1100 (rooms 500-1000 square feet).
 - c. CSU2200 (rooms 1000-2000sqare feet).

B. Vacancy Sensor:

1. Manual-ON operation. Auto adjustable time delays: automatic, fixed (5, 10, 15, 20, 25 or 30 minutes), walk-through, test-mode.
2. Selectable time delay automatically adjusts. Selectable walk-through mode turns lights off three minutes after the room is initially occupied if no motion is detected after the first 30 seconds. Selectable test mode allows quick and easy adjustments.
3. Selectable audible alert for impending shutoff.
4. LED indicating occupancy detection.
5. Built-in light level sensing with simple, one-step setup.
6. Override mode allows sensor to operate as a service switch in the event of a failure. NEMA WD 7 guideline utilized for coverage testing. Sensitivity adjustment: PIR (high/low).
7. Coverage: 180 degrees, up to 1050 sq. ft.; major motion 35' x 30'; minor motion 20' x 15'.
8. 5-year warranty.
9. Loads: Incandescent, fluorescent, compact fluorescent (CFL), magnetic low-voltage (MLV) and electronic low-voltage (ELV), 1/6 hp.
10. Design Make: Pass & Seymour OS300SW.

C. Dual Technology Wall Switch Sensor:

1. Dual Technology Passive Infrared & Ultrasonic.
2. PIR Adjustment Two Settings – Maximum (100%) and Minimum (50%).
3. Ultrasonic Adjustment Ultrasonic sensitivity can be adjusted using a trimpot.
4. Output frequency of transmitter is fixed at 40kHz.
5. Time Delay Adjustable 5 min. to 30 min.
6. Light Level Adjustment Yes, 8fc to 180+fc.
7. Spectral Response 6 to 14 μ m.
8. Field of View 88°;110° Vertical, 360° Horizontal.
9. Frequency 50-60 Hz.

10. Coverage 1050 square feet, 180°.
11. Indicator Light(s) Red & Green LEDs.
12. Sensor Type Multi-directional transmitter/receiver with quartz oscillator.
13. Alerts Selectable, Audible.
14. Pass & Seymour WDT Series.

D. Dimmable wall switch Occupancy/Vacancy Sensor

1. For use with 0-10V, 4 wire, 120V and 277V dimming ballasts and drivers.
2. Pressing and holding the UP button will ramp the lights up to the maximum value as determined by the high trim setting. Pressing and holding the DOWN button will dim the lights down to the minimum value as determined by the low trim setting. By default, the values are set at 100% (10v) for high trim and OFF (0v) for low trim.
3. Automatic-ON (Occupancy) or Manual-ON (Vacancy) operation. Refer to plans for Occupancy and Vacancy Sensor requirements and adjust dip switches accordingly to either Automatic-ON (Occupancy) or Manual-ON (Vacancy).
4. Adjustable time delay from 3, 5, 15 and 30 minutes.
5. Multi-way wiring available up to 4 sensors. All switches can sense each other's dimming events and respond accordingly.
6. 180 degree field of view for use in spaces no larger than 12' x 15'.
7. Design Make: Pass & Seymour PW-311.

E. Power Packs:

1. Provide power packs for low voltage control devices.
2. Universal Voltage Pack with 24 VDC operating voltage to low-voltage occupancy sensors and similar controls.
3. High-efficiency power supply and a high-current relay. Transformer with a primary high voltage input, and a secondary low-voltage output (24 VDC, 114 mA, with relay connected)
4. Secondary output will turn the connected load on and off automatically based on device input.
5. Secondary output will control 24V dampers where called for. Coordinate the exact requirements and location of power pack with the mechanical contractor. Provide raceways as required by the mechanical contractor.
6. When the lighting system detects motion or inadequate ambient light, sensor shall electrically close an internal circuit which sends 24 VDC back to the Power Pack.
7. Design Make Pass & Seymour PWP series.

2.07 SPECIFICATION GRADE DUPLEX RECEPTACLES

- A. Corrosion-resistant, plated steel strap locked in to face and back body to resist pulling away from face/body assembly.
- B. 0.032 inch thick, brass, triple-wipe power contacts for lasting retention.
- C. Easily accessed break-off, line-contact connecting tab for fast, easy split-circuit wiring.
- D. Impact-resistant nylon face and thermoplastic back body.
- E. Accepts #14 - #10 AWG solid or stranded copper or copper-clad wire.
- F. Terminal compartments isolated from each other for positive conductor containment.
- G. Tri-drive terminal and mounting screws.
- H. Auto-ground clip assures positive ground.
- I. Design Make: Pass & Seymour CR20 Series.

2.08 TAMPER RESISTANT SPECIFICATION GRADE DUPLEX RECEPTACLES

- A. Dual mechanical shutter system to help prevent insertions of foreign objects.
- B. Two drive screws anchor strap to back body and face where abrupt removal torque is greatest.
- C. 0.032 inch thick brass triple-wipe power contacts for lasting retention.
- D. Corrosion-resistant plated steel strap is locked in to the face and back body to resist pulling away from the face/body assembly.
- E. Auto-ground clip for positive ground.
- F. Easily accessed break-off line-contact connecting tab for fast and easy split-circuit wiring.
- G. Backed-out tri-drive steel terminal screws.
- H. Side wire capability.
- I. Design Make: Pass & Seymour TR20 series.

2.10 GFCI RECEPTACLES

- A. 20 ampere rated.
- B. No exposed terminals to a finger safe application before, during, and after installation.
- C. Built-in connector features large brass terminal blades to ensure consistent, reliable electrical connections to Plug Connector.
- D. Protection: if critical components are damaged and ground fault protection is lost, power to receptacle is disconnected.
- E. Prevents line-load reversal miswire: no power to the face or downstream receptacles if wired incorrectly.
- F. FSUL Listed (Federal Specification WC596).
- G. Exceeds UL943 voltage surge requirements; survives 100x the required UL 3kA/6kV voltage surge test cycles.

- H. Trip indicator light (red LED).
- I. Mounting screws are shipped captive in the device and wall plate for easier installation.
- J. High-impact-resistant thermoplastic construction.
- K. Zinc-plated steel mounting strap.
- L. Button colors matching the device face.
- M. Dual-direction test and reset buttons.
- N. Class A rated GFCI.
- O. Provide LED type where indicated for healthcare applications.
- P. Design Make: Pass & Seymour PT2095 & Pass & Seymour PT2095HG series

2.11 COVER PLATES

- A. Nylon Cover Plates:
 - 1. Smooth unbreakable nylon construction. (thermoplastic type are not acceptable)
 - 2. Color shall be ivory
 - 3. Flush mounting plates shall be beveled with smooth rolled outer edge.
 - 4. Surface mounting plates shall be beveled and pressure formed for smooth edge to fit box.
 - 5. Where two-gang boxes are required for single gang devices. Provide special plates with device opening in one gang and second gang blank.
- B. Weatherproof Cover Plates:
 - 1. Weatherproof plastic in-use cover
 - 2. Horizontal/vertical cover in clear MM410C that safely covers any electrical outlet
 - 3. Universal Fit to enable same product for all types of receptacles.
 - 4. Attached gasket and mounting hardware
 - 5. Meet or exceeds OSHA and NEC (article 406.8[b][1] wet location requirements with the cord plugged into the receptacle.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to installation verify that outlet boxes are cut in at proper height; that wall openings are neatly cut and will be completely covered by wall plates.
- B. If wall openings were made by general trades notify that contractor and owners representative and direct the cutting and patching requirements. If the openings were made by electrical contractor cut and patch opening using a qualified trades person.
- C. Prior to installation of backbox verify height with architectural elevations. If the device is not shown confirm the height with the architect and engineer. If conflicts arrive and the architect has not been consulted the box shall be relocated at no cost to the owner.
- D. Exact locations and heights of devices in resident rooms will be determined as part of the typical room mock requirement described in 260010.

3.02 OUTLET REQUIREMENTS

- A. Specific outlet types are not called out on the floor plans. Provide outlets as called for as follows:
- B.

<u>Location</u>	<u>Type</u>
C. Common Spaces	Tamper Proof
D. Visitor and Staff Common Spaces	Specification Grade
E. Maintenance and Administrative	Specification Grade
F. Corridors	
G. Mechanical Spaces	Specification Grade
H. Storage Rooms	Specification Grade
I. Offices	Specification Grade with USB Charger
J. Exterior	Specification Grade

3.03 INSTALLATION

- A. Install in accordance with NECA "Standard of Installation."
- B. Install devices plumb and level.
- C. Do not install devices back-to-back
- D. Provide fire proof putty around all device back boxes in resident rooms and other rated walls.
- E. Install switches with OFF position down.
- F. Install wall dimmers to achieve full rating specified and indicated after de-rating for ganging as instructed by manufacturer.
- G. Do not share neutral conductor on load side of dimmers.
- H. Install receptacles with grounding pole on top.
- I. Connect wiring device grounding terminal to outlet box with bonding jumper and to branch circuit equipment grounding conductor.

- J. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- K. Connect wiring devices by wrapping conductor around screw terminal.
- L. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas and above accessible ceilings.
- M. Install protective rings on active flush cover service fittings.
- N. When receptacle is mounted horizontally, neutral pole shall be on top.
- O. Provide extension rings to bring outlet boxes flush with finished surface.
- P. Provide receptacles at locations indicated and where required by special equipment with plug connection. Mount at height 18" AFF; unless noted otherwise on drawings.
- Q. Receptacles shall not be installed back to back unless otherwise noted.
- R. Mount receptacles in offices, corridors, common spaces and utility spaces at 18" AFF to center.
- S. Mount receptacles in patient rooms at 24" AFF to center.
- T. Where "AC" is noted on plans adjacent to a wiring device refer to the architectural elevations and install so outlet is above backsplash. If it is not clear on the elevation issue a request for information prior to roughing.

3.04 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test all receptacles for proper voltage, grounding and polarity.
- E. Test all GFCI receptacles for proper voltage, polarity, grounding, and verify the receptacle trips at 6 milliamperes or less.
- F. Test all receptacles for polarity, ground continuity and ground blade retention force per NFPA 99 Chapter 3-3 Section 3-3.3.3.
- G. Rewire receptacles as required until receptacles test properly.
- H. Clean exposed surfaces to remove splatters and restore finish.

3.05 FUNCTIONAL TESTING

- A. Where Dimmers, Occupancy Sensors, time switches, programmable schedule controls, photo sensors are installed, the following procedures shall be performed:
 - 1. Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance.
 - 2. Confirm that the time switches and programmable schedule controls are programmable to turn the lights off.
 - 3. Confirm that the placement and sensitivity adjustments for the photo sensor controls reduce electric light based on the amount of usable daylight in the space as specified.
- B. Contractor shall submit a written report to Architect, copy to Engineer, on results of each functional test on equipment installed. Report shall contain owner's representative's signature.

3.06 SWITCHES

- A. Provide switches to control outlets, appliances, lighting, etc. as indicated. Mount 48" above finished floor unless noted otherwise.
- B. Do not feed thru local switches unless specifically noted.
- C. Where more than one switch is indicated at one location on 120 volt circuits mount in gangs under common plate.
- D. Locate switches on strike side of door. If switch is indicated at location which would be concealed (behind equipment, etc.) or not on strike side of door, obtain approval of Architect before installation.
- E. Switches shall not be installed back to back unless otherwise noted.

3.07 WALL PLATES

- A. Provide at locations indicated with size openings required for devices indicated.
- B. Multi-gang switches, receptacles, etc. shall be in a common one-piece plate.
- C. Coordinate the configuration of multi-gang switches of four or more with the architect or construction manager prior to rough in

END OF SECTION 26 2726

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

- A. Interior luminaires and accessories.
- B. Exit signs.
- C. Emergency lights
- D. LED drivers and light engines.
- E. Power extenders.
- F. Generator transfer devices.

1.03 STANDARDS REFERENCES

- A. Design Lighting Consortium (DLC).
- B. Energy Star.
- C. NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub. No. LE-1 and LE-2 pertaining to lighting equipment.
- D. ECCC of NYS Compliance: Comply with applicable requirements of the Energy Conservation Construction Code of NYS, Section 805.
- E. ANSI 132.1.
- F. ANSI C78.379: Electric Lamps Incandescent and High Intensity Discharge Reflector Lamps Classification of Beam Patterns.
- G. ANSI C82.1: Ballasts for Fluorescent Lamps Specifications.
- H. ANSI C82.4: Ballasts for High Intensity Discharge and Low Pressure Sodium Lamps (Multiple Supply Type).
- I. ANSI/UL Compliance: Comply with ANSI/UL standards pertaining to lighting fixtures for hazardous locations.
- J. UL Compliance: Provide lighting fixtures which have been UL listed and labeled.
- K. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturer's Association standards and carry the CBM label.
- L. FCC Part 15
- M. IEEE C62.41: Guide for Surge Voltages in Low-Voltage AC Power Circuits.
- N. NFPA 70: National Electrical Code.

- O. NFPA 101: Life Safety Code.
- P. Testing Standards: IESLM79- 08.
- Q. UL1449 3rd Edition Type 4-Surge Protective Devices.
- R. RoHS Compliant (Restriction of Use of Hazardous Substances).

1.04 SUBMITTALS FOR REVIEW

- A. Provide light fixtures and controls for mocking up each of three typical rooms. Fixtures for these areas will not obtain a final approval until these mock ups receive final approval.
- B. Product Data: Provide dimensions, ratings, and performance data. Information on each fixture shall include:
 - 1. Manufacturer and Catalog Number.
 - 2. Dimensioned Construction Drawing(s).
 - 3. Standard Catalog "Cut" Sheet with options highlighted.
 - 4. Photometric Data.
 - 5. Ballast or Driver specifications.
 - 6. Socket Type.
 - 7. Lamp Type.
 - 8. Energy star compliance.
 - 9. CEE compliance.
- C. Provide cut sheets and wiring schematics for low voltage controls.

1.05 QUALITY ASSURANCE

- A. Lighting fixtures shall be standard products of manufacturers regularly engaged in the manufacture of the specific type lighting fixtures specified and shall be the manufacturer's latest standard design that complies with specification requirements. Firms installing the fixtures shall have a minimum of (5) years of successful installation experience on projects with interior lighting work similar to the requirements of this project.
- B. Verify the availability of all fixtures proposed to be used in the execution of the work prior to submitting for approval. The discontinuance of production of any fixture after such approval has been granted shall not relieve the Contractor from furnishing an approved fixture of comparable quality and design at no additional cost
- C. Lighting fixtures shall be as specified in the "Luminaire Schedule." Fixture types, characteristics, photometrics, finishes, etc., correspond to the first manufacturer, and associated catalog number, listed in the "Luminaire Schedule." Provide a sample fixture from the factory for any products not listed as acceptable for approval. The Owner's Representative reserves the right to disapprove any fixture type submitted which is not equal in quality, appearance or performance to the fixture specified.
- D. Drivers and LED boards: The manufacturer shall provide written warranty against defects in material or workmanship, including replacement, for five years from date of manufacture. Drivers and LED boards shall be manufactured in an ISO 9002 Certified Facility.

1.06 SPARE ATTIC STOCK

- A. Provide (5) LED drivers. For each type of fixture with over 30 fixtures

1.07 CONTROLS AND DRIVERS

- A. The drawings indicate 0-10V LED dimming drivers with power extenders and three wire dimmers (hot, neutral, load) in classrooms, assembly spaces and offices. The contractor may provide variations such as 2 or 3 wire dimming drivers without extenders or 0-10V dimmers without power extenders.
- B. The contractor shall provide all branch/switch circuit and control wiring the approved dimming controls.
- C. Where alternate arrangements are proposed the contractor and his lighting representative shall be responsible for selecting and providing proper driver and dimming combinations subject to the following physical and performance criteria:
 - 1. All fixtures must dim smoothly to a minimum of 10% of total lumen output with no visible flicker.
 - 2. Dimmers must fit in existing back boxes for 1995 renovation areas. This includes two dimmers side by side in two gang box for classrooms and assembly spaces.

PART 2 - PRODUCTS

2.01 LUMINAIRES

- A. Furnish Products from acceptable manufacturers listed in the light fixture schedule.
- B. Wattages for LED fixtures are maximum allowed. Where recently released products have decreased wattage for same lumen output, provide the decreased wattage version.
- C. Lenses as called for on schedule meeting the following applicable requirements:
 - 1. Extruded 100 percent virgin acrylic material with a minimum weight of ten ounces per square foot.
 - 2. Type 12: Clear material with 0.125 inch overall thickness with .080 Inch penetration comprised of 3/16 inch square based female cones aligned 45 degrees to the length and width of the panel.
 - 3. Type 19: Clear material with 0.156 inch overall thickness with 0.080 inch penetration comprised of 3/16 inch square based male cones aligned parallel and perpendicular to the length and width of the panel.
 - 4. White Matte: White material with 0.125 inch overall thickness.
 - 5. While Overlay: White material with 0.040 inch overall thickness.
 - 6. The maximum deflection at the center of a 2 foot x 4 foot lens shall be no greater than 0.250 inch. Arched or warped lenses will not be accepted.
- E. Housings:
 - 1. Provide steel, extruded aluminum or spun aluminum as called for on the fixture schedule.

2.02 EXIT SIGNS

- A. Manufacturers:
 - 1. Refer to lighting fixture schedule on the drawings for manufacturer and specifications.
 - 2. Unless otherwise noted on drawings or panel schedules, circuit fixture to nearest un-switched power source. Update panel directory in cover of panel.
- B. Electrical Characteristics:
 - 1. LED electroluminescent type for 120/277 volt supply.
 - 2. Use two LED strips for indirect illumination of the face electroluminescent lamp for direct illumination of the face. Meet or exceed illumination requirements of NFPA-101, and all of the requirements of UL924.

2.03 EMERGENCY LIGHTS

- A. Manufacturers: Refer to lighting fixture schedule on the drawings for manufacturer and specifications.
- B. Unless otherwise noted on drawings or panel schedules, circuit fixture to nearest un-switched power source. Update panel directory in cover of panel.
- C. Premium sealed maintenance free, 6V lithium ion batteries with sufficient capacity to operate the lamps for 1-1/2 hours to an end voltage of 87-1/2% of nominal battery voltage. Three stage charger (constant current, equalize and float charge), relay, low voltage battery disconnect and brownout protection circuits.

2.04 LED DRIVERS AND LIGHT ENGINES

- A. Acceptable Manufacturers:
 - 1. Philips.
 - 2. Lutron.
 - 3. Microsemi.
 - 4. Approved Equal.
- B. General Requirements:
 - 1. The LED driver and board shall have a (5) year warranty.
 - 2. LED lamps shall have a minimum rated life 50,000 hours.
 - 3. LED driver board combinations shall deliver a minimum of 90 lumens/watt.
 - 4. Shall be rated dual voltage 120/277V.
 - 5. Must have surge suppression protection suitable for use in permanently connected products meeting UL1449 3rd Edition Type 4.
 - 6. Must meet ANSI C62.41 Category A surge protection standards up to and including 4 kV.

7. Light engine shall provide 4,000K color temperature.

C. General LED Driver Requirements:

1. LED Driver shall be installed inside an electrical enclosure.
2. Wiring inside electrical enclosure shall have a 600V/105°C rating or higher.
3. Must tolerate sustained open circuit and short circuit output conditions without damage.
4. Maximum allowable case temperature of 70°C.
5. Must comply with the requirements of UL, FCC, ENEC, CE, CQC.
6. The input and output connections shall be factory wiring only. Connection to supply mains shall be determined in the end product.
7. Temperature tested in a 55°C ambient, with the maximum temperatures on the enclosure of 73.1°C.
8. Suitable for use in dry and damp locations.
9. Installed as a built-in component of the end product. The unit shall be installed in compliance with the enclosure, mounting, spacing, casualty, temperature, and segregation requirements of the end product application.
10. The transformer shall employ a Class 130(B) insulation system.
11. Spacing in accordance with the requirements of the Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750, First Edition, Clause 7.8.3 and Table 7.4.

D. 0-10V Dimming Drivers:

1. Physical Characteristics:
 - a. LED Driver shall be installed inside an electrical enclosure.
 - b. Wiring inside electrical enclosure shall comply with 600V/105°C rating or higher.
2. Performance:
 - a. Certified by UL Class2 for use in a dry or damp location.
 - b. Class A sound rating.
 - c. Minimum operating ambient temperature of -40°C.
 - d. Life expectancy of 50,000 hours at Tcase of $\leq 70^{\circ}\text{C}$.
 - e. Life expectancy of 100,000 hours at Tcase of $\leq 62^{\circ}\text{C}$.
 - f. Maximum self rise of 25°C in open air without heat sink.
 - g. Maximum allowable case temperature is 75°C.
 - h. Failure rate $\leq 0.01\%$ per 1,000 hours at Tcase $\leq 70^{\circ}\text{C}$.
 - i. Failure rate of 0.01% - 0.02% per 1,000 hours at Tcase of 70°C - 80°C.
 - j. Must tolerate sustained open circuit and short circuit output conditions without damage.
 - k. Comply with FCC rules and regulations, as per Title 47 CFR Part 15 Non-Consumer (Class A).
 - l. Minimum Dimming range 100-10% or 100-1% as called for.

E. Three (3) Wire Dimming Drivers:

1. Minimum Dimming Range: 100% to 10%.
2. Operating Voltage: 120 – 277 V~ at 50/60 Hz.
3. Rated lifetime of 50,000 hours @ $t_c = 65^\circ\text{C}$.
4. LEDs turn on to any dimmed level without going to full brightness.
5. Nonvolatile memory to restore all driver settings after power failure.
6. Power Factor: > 0.90 at 40 W.
7. Standby Power Consumption: < 1.0 W.
8. Total Harmonic Distortion (THD): $< 20\%$ at 40 W.
9. Inrush Current: < 2 A.
10. Inrush current limiting circuitry to eliminate circuit breaker tripping, switch arcing and relay failure.
11. Turn-on Time: ≤ 1 second.
12. PWM Dimming Frequency: 550 Hz.

F. Two (2) Wire Dimming Drivers:

1. Dimming Range: 100% to 1%.
2. Operating Voltage: 120 V~ at 50/60 Hz (2-Wire Forward Phase Control).
3. Rated lifetime of 50,000 hours @ $t_c = 65^\circ\text{C}$.
4. LEDs turn on to any dimmed level without going to full brightness.
5. Nonvolatile memory restores all driver settings after power failure.
6. Power Factor: > 0.90 at 40 W.
7. Total Harmonic Distortion (THD): $< 20\%$ at 40 W.
8. Inrush Current: < 2 A
9. Inrush current limiting circuitry to eliminate circuit breaker tripping, switch arcing and relay failure.
10. Turn-on time: ≤ 1 second.
11. PWM Dimming Frequency: 550 Hz.

2.05 GENERATOR TRANSFER DEVICE

- A. Compliance with Underwriters Laboratories in accordance with the standards set forth in UL 924, "Emergency Lighting and Power Equipment," and UL Listed for factory or field installation.
- B. Able to convert and control up to (20) regular light fixtures to approved emergency lights.
- C. Automatic Diagnostic Feature that tests fixtures regularly.
- D. Electrical Characteristics:
1. 120/277
 2. 120V or 277V Sensing Input.
 3. 120V or 277V Load.
 4. 20 Amp Ballast Load Rating.
 5. 1800W Load Rating at 120V.
 6. 1500W Load Rating at 277V.
 7. N.C. Contact.
 8. 0-10V Dimming compatibility

E. Mechanical Characteristics:

1. Mounts in 4-11/16" Junction Box with single gang plaster ring.
2. UL94-5VA Rated
3. Temperature: 32°F - 140°F.
4. Color - White.

F. Design Make: LVS Controls EPC-1-D Series

G. Acceptable Manufacturers:

1. LVS Controls.
2. Bodine.
3. DualLite.

2.06 POWER EXTENDER

A. Provide with low-voltage 0-10V dimmable LED drivers and electronic ballasts, to emulate the characteristics of the dimmer that it is connected to in terms of dimming range and resolution.

B. Electric Characteristics:

1. Input Voltage: 108VAC to 305VAC, 60Hz.
2. Load Rating: 20A-2400VA @120VAC, 5500VA @277VAC fluorescent.
3. Power Consumption: 6W @120VAC max, 18W @277VAC max.
4. Dimmer Input: 120V 60Hz.
5. Output Ballast Control: 0-10VDC.
6. Testing/Code Compliance: UL Listed, CSA Certified and FCC Part 15.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
- B. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- C. Exposed Grid Ceilings: Fasten surface mounted luminaires to ceiling grid members using existing hardware.
- D. Install recessed luminaires to permit removal from below.
- E. Install recessed luminaires using accessories and fire stopping materials to meet regulatory requirements for fire rating.
- F. Install clips to secure recessed grid-supported luminaires in place.
- G. Install accessories furnished with each luminaire.
- H. Connect luminaires, emergency lighting units, and exit signs to branch circuit outlets provided under section 260519 using flexible conduit.
- I. Bond products and metal accessories to branch circuit equipment grounding conductor.

- J. Install specified lamps in each exit sign, and luminaire.
- K. General:
1. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's 'Standard of Installation', NEMA standards, and with recognized industry practices.
 2. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Engineer.
 3. Make installation such that the fixture is free of finger marks, flaws, scratches, dents or other imperfections.
 4. Arrangement:
 - a. Align edges of fixtures with walls or other building elements. Where indicated by dimensions or indicated on drawings, maintain indicated arrangement.
 - b. For wall to wall installed light fixtures, field measure length required after completion of the wall construction and prior to ordering the light fixtures. Fabricate in largest lengths allowable.
 5. Recessed Mounting:
 - a. Verify ceiling construction and material prior to ordering light fixtures. Provide plaster frames for plaster ceilings and flanged frames for drywall ceiling. Provide necessary mounting hardware and accessories to adapt fixture to ceiling construction. Provide gaskets, trims, flanges, etc. as required to prevent light leaks around trim. Where installing 'lay-in' type fixtures, provide galvanized supports to the building structure, independent of the ceiling system, at all four corners of the fixture. Each support shall be capable of supporting 100 pounds and each wire shall be a minimum of 12 AWG mild steel. Provide saddle hangers or tie bars attached to runners or between crossbars of ceiling systems as a safety measure. Provide mounting splines or other positive means of maintaining alignment and rigidity. Use a minimum of (2) supports independent of the ceiling for each point source type fixture.
 6. Stem Mounting:
 - a. Use self-aligning hangers in canopies for hanging fixtures true to vertical. Do not deface ceiling or walls. Locate hangers at intersections of joints or at centers of blocks in rooms with patterned type ceiling materials such as acoustic tile. Use hangers capable of supporting four times fixture weight. Align continuous rows of fixtures maintaining fixtures level without rotation about the longitudinal axis. Rigidly support outlet box independent of ceiling system from building structure. Where obstructions prevent direct support of outlet, provide offset or trapeze hangers of outlet box. Stem shall be supported directly from building structure on centers as called for by the manufacturer. There shall be a minimum of (2) stems per individual four-foot light fixture, and (3) stems per individual eight foot light fixture for steel fixtures. Extruded aluminum fixtures shall have hangers as called for by the manufacturer.

7. Surface Ceiling Mounting:
 - a. Mount surface fixtures tight to surface without distorting surface. Space fixtures in continuous rows to correspond to ceiling joint intersections. Continuous row fixtures may be fed by a single outlet where fixtures contain approved wireways and suitable wiring is used. Provide hangers for each fixture, each rated to support four times the fixture weight. Provide offset or trapeze hangers where required. Supports shall be provided on a maximum of 4 foot centers with a minimum of (2) hangers per individual four foot light fixture and (3) hangers per individual eight foot light fixture. Hangers shall be supported from the building structure and independently from ceiling system or other building services.
 - b. Fasten fixtures securely to structural supports.

3.02 FIELD QUALITY CONTROL

- A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.
- B. Examine areas and conditions, under which lighting fixtures are to be installed, and substrate for supporting lighting fixtures. Notify Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.
- C. Refer to respective reflected ceiling plan for each area. Reflected ceiling plans indicate proper light fixture location only. Coordinate the proper arrangement with all other ceiling mounted devices. Contract Documents indicate light fixture characteristics (type), quality, quantity, etc. Verify with the ceiling supplier design of actual ceiling installed in each area and coordinate compatible fixture flange.

3.03 ADJUSTING

- A. Aim and adjust luminaires.
- B. Position exit sign directional arrows as indicated.

3.04 CLEANING

- A. Clean electrical parts to remove conductive and deleterious materials.
- B. Remove dirt and debris from enclosures.
- C. Clean photometric control surfaces as recommended by manufacturer.
- D. Clean finishes and touch up damage.

3.05 REMOVAL OF BALLAST IN EXISTING LIGHT FIXTURES

- A. Assume ballast contains PCB or DEHP materials unless labeled otherwise, or test samples to show materials are not PCB or DEHP; submit test report. Remove all ballast from existing light fixtures indicated on contract documents. Dispose of all ballast which do not have non-PCB or DEHP labels in approved containers and pay all costs to have containers taken to EPA approved incinerators and disposed of per all EPA and OSHA regulations. Follow all EPA and OSHA regulations for transporting containers and materials. If ballast has leaked in existing fixture, remove material deposited in fixture and dispose of those material as listed above. Provide Certificate of Disposal and all associated paperwork to Owner's representative.

3.06 REMOVAL OF LAMPS IN EXISTING LIGHT FIXTURES

- A. Assume all fluorescent lamps contain Mercury materials unless labeled otherwise, or test samples to show materials do not contain Mercury and submit test report. Remove all lamps from existing light fixtures indicated on contract documents. Dispose of all lamps which do not have non-Mercury labels in compliance with the requirements of the New York State Department of Environmental Conservation and all applicable Federal Laws. Follow all regulations for transporting materials. Provide Certificate of Disposal and all associated paperwork to Owner's representative.

END OF SECTION 26 5010

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.02 SCOPE OF WORK

- A. Provide the following Horizontal cabling as called for on the E500 series drawings. Cables shall be multi colored as called for on the drawings. Terminate specific colored cables on dedicated patch panels.
- B. Prior to releasing the cable order obtain approval in writing from the owner's IT director for all cable colors.
- C. Prior to installing any cable meet with the owner's IT director in the field and review each rack lay out with respect to switch, patch panel and wire management placement. Provide a shop drawing showing the agreed upon layout signed off by the owner's IT director.
- D. This section shall include the following
 - 1. Category 6 cable
 - 2. Category 6 Patch Panels
 - 3. Communications Faceplates
 - 4. Termination Jacks

1.03 REFERENCES

- A. The products and work herein specified shall comply with the current additions of the following publications and standards.
 - 1. UL - Underwriter Laboratory
 - 2. NEC – National Electric Code
 - a. Article 725
 - b. Article 770
 - c. Article 800
 - 3. NFPA – National Fire Protection Association
 - 4. NECA - Standard of Installation
 - 5. ANSI – American National Standards Institute
 - 6. NEMA – National Electrical Manufactures Association Article 250

7. EIA – Electronic Industries Alliance
 - a. ANSI/TIA/EIA-568-C.2.
 - b. ANSI/EIA/TIA 569B
 - c. ANSI/EIA/TIA 606A
 - d. ANSI-J-STD-607-A
 - e. ANSI/TIA/EIA-606-A
 8. TIA – Telecommunications Industry Association
 9. IEEE C2 National Electrical Safety Code
 10. FCC - Federal Communications Commission
 - a. CFR 68
 11. BICSI – Building Industry Consulting Services International
 - a. Distribution Methods Manual
 - b. ANSK/NECA/BICSI 568
 12. ISO/IEC 11801
- B. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.04 QUALITY ASSURANCE

- A. All work shall be provided in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents, shall be provided in accordance with industry standards and shall be subject to the control and approval of the Owners representative.
- B. Equipment and materials shall be of the quality and manufactures indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to the approval of the Engineer.
- C. Strictly adhere to all Category 6 (BICSI and TIA) and manufacturer recommended installation practices when installing high performance cabling.
- D. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
- E. The contractor shall furnish a list of (3) installations of equivalent or larger systems that have been installed within the past (2) years and have been operating satisfactorily for a minimum of one year. (Include names and phone numbers of references) with bid.

1.05 SUBMITTALS

- A. Provide manufacturers cutsheets, specifications, and installation instructions for the products herein specified.
 - 1. Category 6 Cable.
 - 2. Patch Panels.
 - 3. Communications Faceplates.
 - 4. Termination Jacks.

PART 2 – PRODUCTS

2.01 CATEGORY 6 100 OHM UNSHIELDED TWISTED PAIR CABLE

- A. Category 6/Class E Unshielded Twisted-Pair (UTP) Cable.
- B. All Cables shall be of round construction.
- C. Each cable shall contain 4 color coded pairs.
- D. Cable shall be listed for the environment where it will be installed (Plenum, Riser, LSZH, etc.)
- E. Category 6 horizontal cabling shall meet or exceed the following specifications:
 - 1. Construction Materials
 - a. Jacket Material PVC
 - b. Conductor Material Bare copper
 - c. Insulation Material Polyolefin
 - d. Separator Material Polyolefin
 - e. Dimensions
 - f. Cable Length 305m | 1000 ft
 - g. Cable Weight 24.62 lb/kft
 - h. Diameter Over Jacket 5.842 mm | 0.230 in
 - i. Jacket Thickness 0.508 mm | 0.020 in
 - 2. Electrical Specifications
 - a. ANSI/TIA Category 6
 - b. Characteristic Impedance 100 ohm
 - c. Dc Resistance Unbalance, maximum 5%
 - d. Delay Skew, maximum 45 ns
 - e. Mutual Capacitance 5.4 nF/100 m @ 1kHz
 - f. Nominal Velocity of Propagation (NVP) 69%
 - g. Operating Frequency, maximum 400 MHz
 - h. Transmission Standards ANSI/TIA-568-C.2 | CENELEC EN 50288-6-1 | ISO/IEC 11801 Class E
 - i. Safety Voltage Rating 300 V
 - j. Dielectric Strength, minimum 1500 Vac | 2500 Vdc
 - k. Note: All electrical transmission tests include swept frequency measurements.

3. Environmental Specifications
 - a. Environmental Space Non-plenum/Plenum
 - b. Flame Test Method CMR/CMP
 - c. Installation Temperature 0 C to +60 C (+32 F to +140 F)
 - d. Operating Temperature -20 C to +60 C (-4 F to +140 F)
 - e. UL Temperature Rating 75 C | 167 F
4. General Specifications:
 - a. Cable Type U/UTP (unshielded).
 - b. Pairs, quantity 4.
 - c. Cable Component Type Horizontal.
 - d. Packaging Type box.
 - e. Conductor Gauge, singles 23 AWG
 - f. Conductor Type, singles Solid

F. Category 6 horizontal cabling shall meet or exceed the performance specifications listed in the following table.

Freq. MHz	IL			NEXT			ACR			PSNEXT			PSACR			ACRF			PSACRF			RL			TCL		ELTCTL	
	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	CS	Std
1	2.0	2.0	2.1	77.3	74.3	92.6	75.3	72.3	90.5	75.3	72.3	90.7	73.3	70.3	88.6	68.8	67.8	85.1	65.8	64.8	83.8	20.0	20.0	34.5	40.0	40.0	35.0	35.0
4	3.8	3.8	3.9	68.3	65.3	85.0	64.5	61.5	81.1	66.3	63.3	82.9	62.5	59.5	79.0	56.8	55.8	73.3	53.8	52.8	72.1	23.6	23.0	33.1	40.0	40.0	23.0	23.0
8	5.3	5.3	5.3	63.8	60.8	80.8	58.5	55.4	75.5	61.8	58.8	78.7	56.5	53.4	73.3	50.7	49.7	67.5	47.7	46.7	66.3	25.4	24.5	34.4	40.0	40.0	16.9	16.9
10	5.9	6.0	6.0	62.3	59.3	79.2	56.4	53.3	73.2	60.3	57.3	77.1	54.4	51.3	71.1	48.8	47.8	65.5	45.8	44.8	64.3	26.0	25.0	35.7	40.0	40.0	15.0	15.0
16	7.5	7.6	7.5	59.2	56.2	76.3	51.7	48.7	68.8	57.2	54.2	74.0	49.7	46.7	66.5	44.7	43.7	61.5	41.7	40.7	60.2	26.0	25.0	35.7	38.0	38.0	10.9	10.9
20	8.4	8.5	8.4	57.8	54.8	74.6	49.4	46.3	66.2	55.8	52.8	72.4	47.4	44.3	64.1	42.8	41.8	59.6	39.8	38.8	58.3	26.0	25.0	37.0	37.0	37.0	9.0	9.0
25	9.4	9.5	9.4	56.3	53.3	73.0	46.9	43.8	63.7	54.3	51.3	70.9	44.9	41.8	61.5	40.8	39.8	57.6	37.8	36.8	56.3	25.3	24.3	38.1	36.0	36.0	7.0	7.0
31.25	10.6	10.7	10.5	54.9	51.9	71.7	44.3	41.2	61.2	52.9	49.9	69.6	42.3	39.2	59.1	38.9	37.9	55.6	35.9	34.9	54.3	24.6	23.6	38.2	35.1	35.1		
62.5	15.3	15.4	14.9	50.4	47.4	66.2	35.1	32.0	51.3	48.4	45.4	64.1	33.1	30.0	49.2	32.9	31.9	49.3	29.9	28.9	48.1	22.5	21.5	36.6	32.0	32.0		
100	19.7	19.8	19.0	47.3	44.3	63.5	27.6	24.5	44.5	45.3	42.3	61.3	25.6	22.5	42.4	28.8	27.8	44.9	25.8	24.8	43.8	21.1	20.1	33.6	30.0	30.0		
155	25.0	25.2	23.9	44.4	41.4	61.3	19.5	16.3	37.4	42.4	39.4	58.8	17.5	14.3	35.0	25.0	24.0	40.8	22.0	21.0	39.7	19.8	18.8	32.0	28.1	28.1		
200	28.8	29.0	27.3	42.8	39.8	58.9	14.0	10.8	31.6	40.8	37.8	56.9	12.0	8.8	29.6	22.8	21.8	38.6	19.8	18.8	37.5	19.0	18.0	31.1	27.0	27.0		
250	32.6	32.8	30.7	41.3	38.3	56.8	8.7	5.5	26.1	39.3	36.3	54.8	6.7	3.5	24.1	20.8	19.8	36.6	17.8	16.8	35.5	18.3	17.3	30.6	26.0	26.0		
300	36.2		33.9	40.1		55.4	4.0		21.5	38.1		53.5	2.0		19.6	19.3		34.8	16.3		33.7	17.8		30.7				
350	39.5		36.8	39.1		54.3	-0.4		17.5	37.1		52.3	-2.4		15.5	17.9		33.4	14.9		32.1	17.3		31.1				
400	42.7		39.4	38.3		53.0	-4.4		13.5	36.3		51.1	-6.4		11.6	16.8		32.1	13.8		30.8	16.9		32.5				
500			44.7			50.7			6.0			48.7			4.0			28.9			27.6			33.8				
550			44.9			50.9			6.0			48.8			3.9			28.7			27.3			33.6				
650			51.5			47.0			4.4			45.0			16.4			24.4			21.9			26.2				

5. The table provides reference values only. All parameters comply with the governing equations over the entire frequency range.

6. All values and equations apply to worst-case channels utilizing four-pair cables with full cross-connects, consolidation points and work area outlets (4 connectors in a channel) for any channel lengths up to 100 meters.

G. Design Make: Belden Data Twist 4800 non-bonded

H. Acceptable Manufacturers:

1. Commscope
2. Berktek
3. Amp

2.02 CATEGORY 6 CONNECTING HARDWARE

- A. Category 6 compliant modular jacks
- B. Performance terminated on a 100M length of cable shall match requirements listed for Category 6 cable
- C. Physical Characteristics
 - 1. Jacks shall be 8 position un-keyed
 - 2. Each jack shall be an individually constructed unit and shall snap mount in an industry standard keystone opening (.760" x .580")
 - 3. Jack housings shall be high impact 94 V-0 rated thermoplastic
 - 4. Jacks shall have a temperature rating of -10 °C (14°F) to 60°C (140 °F) in conformance with ANSI/TIA/EIA-568-A
 - 5. Jacks shall utilize a 2-layer printed circuit board to control NEXT
 - 6. Jack housings shall fully encase and protect printed circuit boards and IDC fields.
 - 7. Housing shall be ultrasonically welded for tamper resistance.
 - 8. Modular jack contacts shall accept a minimum of 2500 mating cycles without degradation of electrical or mechanical performance.
 - 9. Contacts will maintain a minimum vertical deflection force of 100 grams over deflection window.
 - 10. Modular jack contact wires shall be formed flat for increased surface contact with mated plugs.
 - 11. Contacts shall be arranged on the PC board in 2 staggered arrays, one array has 6 contacts and the other array has 2 contacts.
 - 12. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.
 - 13. Contact Plating shall be a minimum of 50 micro inches of hard gold in the contact area over 50 micro-inch of nickel.
 - 14. Jack termination shall follow the industry standard 110 IDC.
 - 15. IDC contact termination towers shall be paired and angled at 29.5 degrees.
 - 16. IDC contacts shall be laid out in staggered arrays of 4 sets of 2 contacts.
 - 17. Jacks shall have a designation indicating Category 6 on the nose which can be plainly seen from the front of the faceplate. Bottom of jack shall have date code and an abbreviated catalog number.

18. Jacks shall utilize a paired punch down sequence. Cable pair twists shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.
19. 110 IDC shall utilize 100 micro-inch tin lead plated (60% tin/40%lead) over phosphor bronze over nickel.
20. Jacks shall terminate 22-26 AWG stranded or solid conductors.
21. Jacks shall terminate insulated conductors with outside diameters up to .050"
22. Jacks shall be compatible with single conductor 110 impact termination tools.
23. Jacks shall include translucent wire retention stuffer cap, that hold terminated wires in place and allow the conductors to be visually inspected in the IDC housing.
24. Stuffer cap shall have a positive locking latch to provide conductor strain relief.
25. Stuffer cap used for wire termination with channel lock style pliers.
26. Jacks shall be compatible with TIA/EIA 606 color code labeling
27. Jacks shall accept snap on icons for identification or designation of applications.
28. Jacks shall be available in 6 colors for identification or designation of applications at the workstation or telecommunication room.
29. Jacks shall have universal wiring designation.
30. Jacks shall be marked with the T-568A wiring scheme.
31. Jacks shall have an attached color coded wiring instruction label housed between the IDC termination towers.
32. Jacks shall be manufactured in the USA
33. Jacks shall be designed for 100 Ohm UTP cable termination
34. Jacks shall be UL LISTED 1863 and CSA certified.
35. Jacks shall be made by an ISO 9002 Certified Manufacturer.

D. Design Make: Belden Cat6+

2.06 UTP PATCH PANELS

A. Physical Characteristics

1. Panels shall be made of 16ga cold rolled steel with a black powder coat finish in 48 port configurations.
2. Panels shall be manufactured with a rolled-edge at the top and bottom for stiffness.
3. Panels shall have 48 modular openings

4. Panels shall have Flame retardant UL 94 V-0 modular jacks with high performance copper alloy contacts and precious metal plating.
5. Panels shall be equipped with 110-style termination made of fire retardant UL 94V0 rated thermoplastic and tin lead solder plated IDC.
6. Panels shall have port identification numbers on both the front and rear of the panel. Front port identification on the 48 port panels shall be located between the rows of jacks.
7. Panels shall have rear cable support bar for strain relief. Cable support bar shall attach to the rear of the patch panel itself without the use of additional fasteners or screws.
8. Panels shall feature vertical panel ID label holders. Provide laser printed adhesive labels.

B. Design Make: Belden Cat6+

PART 3 – INSTALLATION

3.01 COORDINATION

- A. Prior to terminating horizontal cables in rack mounted patch panels meet with the owner's IT staff and service providers to determine exact rack layout.

3.02 GENERAL

- A. Firestop conduit openings after the cable installation is complete.

- B. Separation from Electromagnetic Interference

Condition	Minimum Separation Distance
Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways.	610 mm (24 in)
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	305 mm (12 in)
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal pathway.	152 mm (6 in)
Electrical motors and transformers.	1194 mm (47 in)

- C. Installing cables above suspended ceilings

1. Pull or place cables into the zone pathway.
2. Leave sufficient slack in the ceiling to reach any telecommunications outlet/connector within the zone.

3. Where zone pathways are not provided, divide the floor area into direct-run telecommunications zones.
 4. Run all the cables to the center point of their zones.
 5. From the center point of each zone, distribute the cables to work areas within that zone.
 6. At the center point of each telecommunications zone, support all cables with a cable tie or similar device. Tightly cinched cable ties may have a detrimental effect on transmission performance and should be avoided.
 7. Coil in a figure eight any cable that is not in service back to the end of the zone pathway. When required, cable-tie these coiled cables.
 8. Label the cables and pathways for easy recognition and establish a working database for ongoing identification and maintenance of horizontal cables and pathways.
 9. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 inch intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- D. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-B maximum fill for the particular raceway type.
- E. Riser rated cable shall be installed in metallic conduit when installed in a plenum space.
- F. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.

3.03 UTP CABLE

- A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.
- B. All wiring concealed in new walls or soffits shall be installed in metal conduits.
- C. Wiring in existing walls with hollow cavities may be installed loose.
- D. All exposed wiring shall be installed in surface metal raceway.
- E. All wiring above ceilings shall be installed in cable tray or open top cable hangers and brackets.
- F. Cable hangers above accessible ceilings shall be installed 4' on center attached to building structure. If cables have more than 12" of sag, install more hangers.
- G. Do not untwist cable pairs more than 0.5 in. when terminating.
- H. The Contractor shall be responsible for replacing all cables that do not pass required bandwidth and throughput tests.
- I. Maximum length shall be 90 meters. (295 ft)
- J. Maximum patch cable shall be 5 meters (16 ft)

- K. Provide 10 ft service loop in the communications equipment room. Provide 3-foot service loop in ceiling above outlet. Slack should not be stored in bundled loops. Cable loops have had a degrading effect on cabling performance. Cable slack should be stored in an extended loop or in a figure-eight configuration to alleviate stress.
- L. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.
- M. Install cable in neat and workmanlike manner. Neatly bundle and tie all cable in closets. Leave sufficient cable for 90o sweeps at all vertical drops.
- N. Do not tie-rap cable to a perpendicular support. Tie-raps shall be used to secure cables to other like cables or to an approved tie mount. Do not over tighten cable ties.
- O. Install category 6 cable in a separate open cable hanger segment. Do not install with coaxial, optical fiber cable or any other cable type. If cables have more than 12" of sag, install more hangers.
- P. Do not install UTP cable with more than 110N (25 lbs) pull force, as specified in EIA/TIA and BICSI TDDM practices. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on: long pulls inside conduit, pulls of multiple cables into a single small bore conduit, on conduit runs greater than 100 lineal feet with bends of opposing directions, and in conduit runs that exceed 180 degrees of accumulated bends. Use of tensile rated cords (i.e. fishing line) should be used for difficult or questionable pulls - to judge to go/no-go condition of the conduit and pulling setup.
- Q. Care must be taken so that the cable does not bend at any location to a radius less than ten times the diameter of the cable. A cable feeder guide of suitable dimensions should be used between the cable reel and the face of the duct to protect the cable and guide it into the duct as it is payed off the reel.
- R. As the cable is payed off the reel, it should be carefully watched and inspected for sheath defects. If defects are noticed, the pulling operation should be stopped immediately and the Engineer promptly notified of the defect. Kinks and/or other irregularities in the cable sheath should be removed or corrected as directed by the engineer.
- S. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- T. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.
- U. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- V. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers to support the cabling.
- W. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.
- X. Leave a minimum of 12" of slack for twisted pair cables at the outlet. Cables shall be coiled in the in-wall box, surface-mount box or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. In hollow-wall installations where box-

eliminators are used, excess wire can be stored in the wall. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

- Y. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- Z. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.04 UTP MODULAR JACKS

- A. All cables shall be terminated with modular jacks that snap into a faceplate mounted on a wall outlet box, surface raceways or power pole.
- B. Outlet boxes shall be secured to building with mechanical fasteners. Adhesive fasteners are not allowed.
- C. Jacks shall be installed to provide minimal signal impairment by preserving wire pair twists as close as possible to the point of mechanical termination. The amount of untwisted in a pair as a result of termination to the jack shall be no greater than 0.5 inches (13mm).
- D. Jacks shall be installed according to manufacturer's instructions and properly mounted in plates, frames, housings or other appropriate mounting device.
- E. Jacks shall be installed such that cables terminated to the jacks maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts. Cables shall be terminated on jacks such that there is no tension on the conductors in the termination contacts.
- F. All extra openings to be filled with blank inserts.
- G. Terminate cable per EIA/TIA T-568B standard pin assignments.
- H. Remove only as much cable jacket as is required for termination and trimming. Follow the manufacturer's instructions for mounting, termination, and cable management. Minimize the amount of untwisting in a pair as a result of termination to connecting hardware. For untwisting cabling, maintain pair twists as close as possible to the termination point. The amount of untwisting must not exceed 12.7 mm (0.5 in) for category 5e and higher cables.

3.05 TESTING

- A. Refer to Section 271600.

3.06 COMPLETION AND ACCEPTANCE

- A. In all spaces that have had floor or wall penetrations, hammer drilling, or core boring activities - a through brooming, vacuuming, and wet mopping/sponging shall be preformed. Cleaning shall include floors, walls, ladder trays, tops of cabinets/racks, existing/new passive and active components, per manufacturer recommendations.

- B. Submit copies of the following:
 - 1. Cable Test Reports (at substantial completion).
 - 2. Cable tension reports for optical fiber pulls backbone pulls over 200'.

3.07 PATCH PANELS.

- A. Panels shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the patch panel shall be no greater than 0.5 inches (13 mm)
- B. Panels shall be installed according to manufacturer's instructions and properly mounted to a rack, cabinet, bracket or other appropriate mounting device.
- C. Panels shall be installed such that cables terminated to the panel can maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts.
- D. Cables shall be terminated on the panels such that there is no tension on the conductors in the termination contacts. Panels shall be properly labeled on front and back with the cable number and port connections for each port, as per cable schedule drawings.
- E. All cables shall be neatly "dressed out" in equipment rooms. Cables to be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within a bundle, where the label is obscured from view shall not be acceptable.
- G. Install factory supplied patch panel labels, in the corresponding T568B configuration, in all UTP patch panels, BEFORE beginning to terminate cables. Cables terminated onto a patch panel without said port label strip shall not be acceptable.
- H. The cable jacket shall be maintained as close as possible to the termination point.

3.08 CEILING TILES

- A. The contractor shall replace all ceiling tiles that are damaged due to cable installation. Tiles shall match the existing.
- B. Prior to beginning work walk the proposed cable routes and document any existing damage with the construction manager.

END OF SECTION 27 1500

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract

1.02 SCOPE OF WORK

- A. Provide labor, materials, equipment, and services to perform the work required for a complete installation as required in the Contract Documents.
- B. This section includes the minimum requirements for the testing, certification administration and identification of backbone and horizontal cabling, including;
 - 1. Tester Calibrations / Factory Requirements.
 - 2. UTP testing and testers.
 - 3. Fiber Optic testing and Testers
 - 4. Labels and labeling.
 - 5. Reports.
 - 6. Documentation.
 - 7. Record Copy and As-Builts.
 - 8. Test Acceptance.
 - 9. Warranty.

1.03 REFERENCES

- A. The products and work herein specified shall comply with the current additions of the following publications and standards.
 - 1. UL - Underwriter Laboratory
 - 2. NEC – National Electric Code
 - a. Article 725
 - b. Article 770
 - c. Article 800
 - 3. NFPA – National Fire Protection Association
 - 4. NECA - Standard of Installation
 - 5. ANSI – American National Standards Institute
 - 6. NEMA – National Electrical Manufactures Association
 - a. Article 250
 - 7. EIA – Electronic Industries Alliance
 - a. ANSI/EIA/TIA 568B.X
 - b. ANSI/EIA/TIA 569A
 - c. ANSI/EIA/TIA 606A
 - d. TIA/EIA-J-STD-037

- 8. TIA – Telecommunications Industry Association
 - 9. IEEE C2 National Electrical Safety Code
 - 10. FCC - Federal Communications Commission
 - a. CFR 68
 - 11. BICSI – Building Industry Consulting Services International
 - a. Distribution Methods Manual
 - b. ANSK/NECA/BICSI 568
 - 12. ISO/IEC 11801
- B. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.04 QUALITY ASSURANCE

- A. All work shall be provided in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents, shall be provided in accordance with industry standards and shall be subject to the control and approval of the Owners representative.
- B. Equipment and materials shall be of the quality and manufactures indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in everyway to that of the equipment specified, and subject to the approval of the Engineer.
- C. Strictly adhere to all Category 6 (BICSI and TIA) and manufacturer recommended installation practices when installing high performance cabling.
- D. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
- E. The contractor shall furnish a list of three (3) installations of equivalent or larger systems that have been installed within the past two (2) years and have been operating satisfactorily for a minimum of one year. (Include names and phone numbers of references) with bid.

1.05 SUBMITTALS

- A. Provide manufactures cut sheets, specifications, and installation instructions for the products herein specified.
- B. Cable testers.
- C. Test heads.
- D. Adapter cords.
- E. Latest version of software applicable for each tester planned for use.

- F. Provide written factory calibration recommendation letter and factory recommended field calibration intervals with bid.
- G. Provide signed manufacturer factory calibration certification for each copper and fiber tester owned at time of bid response as a submittal. Certification shall have serial number, date and version of software of each tester.
- H. For each tester planned for use on this project, provide a letter from the tester manufacturer indicating the correct interface adapters and test cords, and set-up procedures required to test perform the Category 6 permanent link and the Category 6, channel tests with the products identified for use on this project and the warranty requirements called for.
- I. Sample documentation from previous job for administration, test results and as-built drawings.
- J. At time of testing, provide a factory calibration certificate for each tester used and include these in each test report binder at the completion of the project.
- K. Test reports (submit prior to substantial completion punch list is performed)
- L. Two copies in binder format and 4 copies on compact disks containing all summary reports, full plot data test results, tester software tools required to view and inspect and print any selection of the test reports, spreadsheets, end to end reports and as built drawings called for at the completion of job.. The database for the completed job shall be stored and delivered on CD including the software tools required to view, inspect, and print any selection of test reports.
- M. Technician certificates for successful completion of training for each of the field testers proposed to be used in this project.
- N. One copy of a binder and two copies on compact disks containing all digital photographs called for at the completion of the job.

PART 2 – PRODUCTS

2.01 UTP TEST EQUIPMENT

- A. Field test instruments shall meet the requirements of ANSI/TIA/EIA-568-C.2.1.
- B. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years experience in producing field test equipment.
- C. Manufacturers must be ISO 9001 certified.
- D. All test tools of a given type shall be from the same manufacturer, and have compatible electronic results output.
- E. Test adapter cables/test heads must be approved by the manufacturer of the test equipment, for the specific cable and connectivity product used on this project. Adapters from other sources are not acceptable. Obtain written confirmation that the test heads and adapter planned for use are proper and also obtain a written confirmation from the wire and connectivity manufacturers that they also agree with the test heads and adapter selection chosen by the tester manufacturer.
- F. Baseline accuracy of the test equipment must exceed TIA Level III, as indicated by independent laboratory testing.

- G. A level III test unit is required to verify category 6 performance for both Category 6 permanent link and channel performance.
- H. Test equipment must be capable of certifying Category 5, 5e, and 6 links.
- I. Test equipment must have a dynamic range of at least 100 dB to minimize measurement uncertainty.
- J. Test equipment must be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
- K. Test equipment must include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
- L. Test equipment must be capable of running individual NEXT, return loss, etc measurements in addition to autotests. Individual tests increase productivity when diagnosing faults.
- M. Test equipment must include a library of cable types by major manufacturer.
- N. Test equipment must store at least 1000 Category 6 or 6 autotests in internal memory.
- O. Test equipment must be able to internally group autotests and cables in project folders for good records management.
- P. Test equipment must include technology for support of advanced measurements.
- Q. Test equipment must make swept frequency measurements in compliance with TIA standards.
- R. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.
- S. The basic tests required are:
 - 1. Wire Map
 - 2. Length
 - 3. Attenuation
 - 4. NEXT (Near end crosstalk)
 - 5. Return Loss
 - 6. ELFEXT Loss
 - 7. Propagation Delay
 - 8. Delay skew
 - 9. PSNEXT (Power sum near-end crosstalk loss)
 - 10. PSELFEXT (Power sum equal level far-end crosstalk loss)
- T. Shall test cable for compliance with the following applicable standards:
 - 1. TIA Category 6: Permanent Link and Channel
 - 2. TIA Category 3 and 5 per TIA TSB-67: Basic Link or Channel
 - 3. ISO/IEC 11801 and EN 50173 Class C and D: Link
 - 4. ISO/IEC 11801 and EN 50173 Class C and D (new): Permanent Link or Channel
 - 5. Aus/NZ Class C and D: Basic Link or Channel
 - 6. STP cabling, (IBM Type 1, 150 Ω)
 - 7. ANSI TP-PMD IEEE 802.3 10BASE5, 10BASE2: Ethernet with coaxial cabling

8. IEEE 802.3 10BASE-T, 100BASE-TX, 1000BASE-T: Ethernet with twisted pair cabling IEEE 802.5: Token Ring, 4 Mbps or 16 Mbps
- U. Shall perform the following tests as a minimum:
1. NEXT, NEXT @ Remote
 2. Wire Map
 3. Characteristic Impedance
 4. Length
 5. DC Loop Resistance
 6. Propagation Delay Return Loss (RL), RL @ Remote
 7. Delay Skew
 8. Attenuation
 9. Attenuation-to-Crosstalk Ratio (ACR), ACR @ Remote
 10. Power Sum ACR, PSACR @ Remote
 11. ELFEXT, ELFEXT @ Remote
 12. Power Sum ELFEXT, PSELFEXT @ Remote
 13. Power Sum NEXT, PSNEXT @ Remote
- V. Shall use injector for complete wire mapping and TDR for determining cable length.
- W. Shall measure NEXT for all six pair combinations and Attenuation on all four pairs from 1.0 to 350 MHz.
- X. Design Make: Fluke "DSP 4000 or 4300 series"
- Y. Acceptable Manufacturers:
1. Agilent
 2. WaveTek
 3. Lantek
 4. Wirescope

2.02 FIBER OPTIC CABLE

- A. Field test instruments for multimode fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-14-A.
- B. Field test instruments for multimode fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-7.
- C. Multimode optical fiber light source
 1. Provide 850nm and 1300nm +/- 20 nm wavelength LED light sources
 2. Spectral width of sources shall be <= 50nm for 850nm wavelengths and <= 140nm for 1300nm wavelengths.
 3. The output of the light source shall be 8 MW for 62.5um core optical fiber
 4. Output Stability +/- 0.40 dB from 0 to 50 degrees C
 5. Long Term output stability +/- 0.10dB at 25 degrees C
 6. Power shall be from rechargeable Ni-Cad batteries
 7. Connector types shall include: SMA, FC, ST and SC
 8. Design make: Siecor Light source

9. Acceptable Manufacturers:
 - a. Fluke
 - b. Wavetek
 - c. Lantek
 - d. Amp

- D. Single mode optical fiber light source
 1. Provide 1300nm and 1500nm +/- 20 nm wavelength Laser light sources
 2. Output Stability +/- 0.40 dB from 0 to 50 degrees C
 3. Long Term output stability +/- 0.10dB at 25 degrees C
 4. Power shall be from rechargeable Ni-Cad batteries
 5. Connector types shall include: SMA, FC, ST and SC
 6. Design make: Siecor OS-200D
 7. Acceptable Manufacturers:
 - a. Fluke
 - b. Meson
 - c. Amp

- E. Optical Power Meter
 1. Calibrates against the National Institute of Standards and Technology (NIST) standard.
 2. Provide 850nm, 1300nm and 1500nm +/- 20 nm wavelength test capability
 3. Measurement range shall be from 10 to -60 dBm
 4. Accuracy shall be +/- 5% at 0 to -50dBm and +/- 10% 10 to 0dBm and -50 to -60 dBm.
 5. Resolution shall be 0.1 dB
 6. Connector types shall include: SMA, FC, ST and SC
 7. Acceptable Manufacturers:
 - a. Fluke
 - b. Meson
 - c. Amp

- F. Optical Time Domain Reflectometer (OTDR) Only if required troubleshooting existing or newly installed cable.
 1. Dual selectable wavelength: 850/1300 nm for multimode
 2. Dual selectable wavelength: 1310/1550 nm for singlemode
 3. Selectable cable index of refraction.
 4. Visual fault locator for continuity checks and dead zone fault protection.
 5. Display and printer connection for hard-copy documentation
 6. Equipped with launch jumper cable of sufficient length to offset entry "deadzone".
 7. Design make: Siecor
 8. Acceptable Manufacturers:
 - a. Fluke
 - b. Meson
 - c. Amp

2.03 LABELS

- A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- B. Shall be preprinted or laser printed type. Handwritten labels are not acceptable.

- C. Where used for cable marking provide vinyl substrate with a white printing area and a clear “tail” that self laminates the printed area when wrapped around the cable. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow – so that the labels are easily distinguishable.
- D. Where insert type labels are used provide clear plastic cover over label.
- E. Provide plastic tape 6 inches wide continuously printed and bright colored 18” above all direct buried services.
- F. Provide engraved plastic laminated labels, signs and instruction plates. Labels shall be made of engraving stock melamine plastic laminate. Use 1/16” minimum for signs up to 20 square inches or 8 inches in length. Use 1/8” thick for larger sizes. All labels shall be punched for mechanical fastening.
- G. Acceptable Manufacturers:
 - 1. W.H. Brady
 - 2. Panduit
 - 3. Ideal

PART 3 – EXECUTION

3.01 GENERAL

- A. Upon completion of the installation, the telecommunications contractor should provide three (3) full documentation sets to the Engineer for approval.
- B. Documentation should be submitted within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine-generated (final) copies of all drawings should be submitted within 30 working days of the completion of each testing phase. At the request of the Engineer, the telecommunications contractor should provide copies of the original test results.
- C. The Engineer may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests should be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test should be at no additional cost to the Owner
- D. Test documentation should be provided on disk within three (3) weeks after the completion of the project. The disk should be clearly marked on the outside front cover with the words “Project Test Documentation”, the project name, and the date of completion (month and year). The results should include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document should detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment

3.02 COPPER CABLE TEST

- A. A level III test unit is required to verify category 6 performance, shall be updated with the latest version of tester software at time of testing and shall be factory tested/calibrated within one of time of testing. At time of testing, provide a factory calibration certificate for tester used and include these in each test report binder at the completion of the project.
- B. Visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport. Visibly damaged goods are to be returned to the supplier and replaced at no additional cost to the Owner.
- C. If post-manufacture performance data has been supplied by the manufacturer of cables or connecting hardware, copies of such data are to be kept for inclusion in the Documentation for final Record Copy deliverables and made available to the Owner upon request
- D. Test 100% of installed backbone copper cabling for
 - 1. Wire Map
 - 2. Length

3.03 100 OHM UTP CABLE TESTING

- A. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B.
- B. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
- C. The testing parameters called for in this section shall apply for up to 90 meters of horizontal cable, a work area equipment cord, an RJ45 outlet and 2 cross connect connections in the closet.
- D. Wire Map
 - 1. The wire map test shall verify pair to pin termination at each end and check for connectivity errors. The wire map shall indicate the following for each of the eight conductors:
 - a. Continuity to the remote end
 - b. Shorts between any two or more conductors
 - c. Crossed pairs or Reversed Pairs
 - d. Split Pairs
 - e. Any other miswiring
- E. Performance
 - 1. Cables shall be tested for conformance called for in Section 271500.

F. Data reporting and accuracy

1. General: a Pass or Fail result for each parameter shall be determined by the allowable limits for each parameter. If the test result of a parameter is closer to the test limit than the accuracy of the tester it shall be marked with an asterisk. Data at all measured points shall be uploaded to a P.C. and printed on a laser printer.
2. Wire Map: Wire map tests shall be marked "Pass" if wiring is determined correct.
3. Length: Test results shall be provided in meters and marked "Pass or Fail" based on the length vs. allowable length.
4. Attenuation: Report the attenuation value and the frequency at point of failure or the highest frequency passed. Measured attenuation values lower than 3dB used for a pass/fail determination. Report the attenuation per unit length for links longer than 15 meters. Attenuation shall be measured from 1 MHz to 16 Mhz (Category 3) or 100 Mhz (Category 5) in 1 MHz steps.
5. NEXT: Report the NEXT value and "pass or fail" for samples based on the following

Frequency Range (MHz)	Maximum Step Size (MHz)
1-31.35	0.15
>31.25-100	0.25
6. Submit copies in binder format and 4 copies on compact disks containing all summary reports, full plot data test results, tester software tools required to view and inspect and print any selection of the test reports, spreadsheets, end to end reports and as built drawings called for at the completion of job.

3.04 OPTICAL FIBER CABLE TESTING

- A. All fiber testing shall be performed on all fibers in the completed end to end system.
- B. Comply with Tier-two testing as defined in TSB-140. which included loss and length testing with an optical loss test set (OLTS) and also an OTDR trace of the installed cable plant. By incorporating the proposed two-tier testing method, installers have the most complete picture of the fiber installation and network owners have proof of a quality installation
- C. Testing shall consist of an end to end power meter test performed per EIA/TIA-455-53A. The system loss measurements shall be provided at 850 and/or 1300 nanometers for multimode fibers and 1310 and/or 1550 nanometers for single mode fibers. These tests also include continuity checking of each fiber.
- D. There shall be no splices unless clearly called for.
- E. Test all fibers with launch and far end cable of sufficient length for the OTDR to be able to see through all installed connectors.
- F. Localized attenuation shall not exceed 0.5 dB at any point.
- G. Backbone multimode fiber shall be tested in both directions at both 850nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A method B.

- H. Backbone single mode fiber shall be tested in both directions at both 1310nm and 1550.
- I. Backbone multimode fiber cabling shall be tested at both 850 nm and 1300 nm (or 1310 and 1550 nm for single mode) in both directions.
- J. Test set-up and performance shall be conducted in accordance with ANSI/EIA/TIA-526-14 Standard, Method B.
- K. Where links are combined to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. ONLY BASIC LINK TEST IS REQUIRED. The contractor can optionally install patch cords to complete the circuit and then test the entire channel. The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA/EIA Standard.
- L. Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements.
- M. Backbone Cable
 - 1. Test the cable on the reel for continuity before installing it, to insure no damage was done in shipment from the manufacturer to the job site.
 - 2. After installation and termination, test each segment of the cable plant individually as it is installed, to insure each connector and cable is good.
 - 3. Link attenuation is the only required field test except for the patched runs in the campus backbone system where an OTDR test will be required. Use launch cables at each end and provide print outs showing all connectors. OTDR will also be required to determine bad connections or damage when the link attenuation test fails.
 - 4. Maximum localized attenuation allowed is 2dB.
 - 5. Backbone multimode fiber shall be tested in both directions at both 850nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A method B.
 - 6. Backbone single mode fiber shall be tested in both directions at both 1310nm and 1550 nm in accordance with ANSI/EIA/TIA-526-14A method A.1.

7. Multimode fiber shall conform to the following:

850 nm:

Length (meters)	Attenuation (dB)
500	3.5
1000	5.5
1500	7.5
2000	9.0

1300 nm:

Length (meters)	Attenuation (dB)
500	2.2
1000	3.0
1500	3.8
2000	4.5

8. Single Mode Fiber shall conform to the following (note: taken at

Length (meters)	Attenuation (dB)
500	2.0
1000	2.5
1500	3.0
2000	3.5
2500	4.0
3000	4.5

Outside:

Length (meters)	Attenuation (dB)
500	1.8
1000	2.0
1500	2.2
2000	2.5
2500	2.8
3000	3.0

- N. Provide attenuation and cable length test results for all installed cable pairs.

3.05 TEST DOCUMENTATION

- A. Test report documentation shall be provided in a three ring binder(s) and CD's within 1 week after the completion of the project. The binder and disks shall be clearly marked on the outside front cover and spine with the words "Test Results", the project name, and the date of completion (month and year).
- B. The binder and electronic folder/files shall be divided by major heading tabs (or in the case of electronic files, be placed into a folders structure similar to the hardcopy tests of this section).
- C. Major heading tabs (folders) shall be divided into Horizontal and Backbone. Each shall be further sectioned by test type and by CER and rack. Additional tabs for summary reports by CER shall also be provided.

3.06 IDENTIFICATION & RECORDS

A. Pathways

1. Cable hanger runs – provide an as built drawing indicating cable hanger routing throughout the facility.

B. Cables

1. Cables shall be marked at each endpoint and at all intermediate pull or junction boxes. Label cables as called for on drawings.
2. Provide written records in computer generated, table format for all cables, with the as-built drawings. The table shall include the following information:
 - a. Cable Identifier
 - b. Cable type
 - c. Length
 - d. Room number

C. Station Outlets

1. Provide 606 insert with clear plastic label cover on faceplates.
2. Provide a laser printed label in the insert.
3. Provide laser printed adhesive labels on station outlets in surface metal raceway.
4. Label shall have the following designation: IDF-Patch Panel- Port Number eg. 1B24
5. Write the cable identifier of each cable in permanent marker on the inside of each faceplate.

D. Patch Panels

1. Label patch panels with laser printed adhesive markers
2. Each panel shall be labeled using a Letter designation Access Point A, B etc.
3. Each patch panel port shall be identified with the room number that the station outlet is located in.

3.07 AS-BUILT DRAWINGS

- A. Provide as-built drawings showing all pathways, Station outlets, equipment rooms and entrance facilities on 1/8 scale floor plans.
- B. AutoCAD plans with original cable locations will be furnished for use with as built drawings.

END OF SECTION 27 1600

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:
 - 1. 26.00 Electrical
 - 2. 26.05 Common Work Results for Electrical
 - 3. 21.10 Water-Based Fire-Suppression System
 - 4. 21.22 Clean Agent Fire Extinguishing Systems
 - 5. 23.00 Heating, Ventilating, and Air-Conditioning (HVAC)
 - 6. 25.00 Integrated Automation
- C. The system and all associated operations shall be in accordance with the following:
 - 1. 2020 New York State Building and Fire Codes
 - 2. NFPA 72, National Fire Alarm Code
 - 3. NFPA 70, National Electrical Code
 - 4. NFPA 101, Life Safety Code,
 - 5. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
 - 6. ANSI/ASME A17.1 / CSA B44, Safety Code for Elevators and Escalators
 - 7. ICC/ANSI A117.1 Accessible and Useable Buildings and Facilities,
 - 8. Local Jurisdictional Adopted Codes and Standards
 - 9. ADA Accessibility Guidelines

1.02 SUMMARY

- A. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.
- B. All equipment must be from JCI/Simplex and integrated into the existing Simplex 9100ES fire alarm system. Contact Mr. Karl Bach 1399 Vischer Ferry Rd, Clifton Park, NY 12065 USA; Tel: 518-952-6040 | Direct: 518-952-6043
- C. Work covered by this section includes the furnishing of labor, equipment, and materials for modification of the fire alarm system as indicated on the drawings and specifications.

1.03 DEFINITIONS

- A. ADA: Americans with Disabilities Act
- B. AHJ: Authority Having Jurisdiction
- C. ANSI: American National Standards Institute
- D. ASME: American Society of Mechanical Engineers
- E. FACP: Fire Alarm Control Unit
- F. FM: Factory Mutual
- G. IBC: International Building Code

- H. ICC: International Code Council
- I. IDC: Initiating Device Circuit
- J. IEEE: Institute of Electrical and Electronic Engineers
- K. IFC: International Fire Code
- L. IMC: International Mechanical Code
- M. IRI: Industrial Risk Insurers
- N. LED: Light-emitting diode.
- O. NAC: Notification Appliance Circuit
- P. NFPA: National Fire Protection Association
- Q. NICET: National Institute for Certification in Engineering Technologies.
- R. RAC: Releasing Appliance Circuit
- S. SLC: Signaling Line Circuit
- T. UL: Underwriters Laboratories
- U. ULC: Underwriters Laboratories, Canada

1.04 SCOPE OF WORK

- A. Provide modifications to the existing Simplex 4100ES fire alarm system per the electrical drawings.

1.05 SYSTEM DESCRIPTION

- A. General: Provide initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.
- B. Wiring/Signal Transmission:
 - 1. Transmission shall be hard-wired using separate individual circuits for each zone of alarm operation, as required or addressable signal transmission, dedicated to fire alarm service only.
 - 2. System connections for initiating device circuits shall be B, Style D, signaling line circuits shall be Class B, Style 4 and notification appliance circuits shall be Class B, Style Y.

1.06 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
- B. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
- C. Wiring diagrams from manufacturer.
- D. Shop drawings showing system details including location of FACP, all devices, circuiting and details of graphic annunciator.
- E. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.

- F. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
- G. Product certification signed by a certified representative of the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
- H. Record of field tests of system.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: A factory authorized installer is to perform the work of this section.
- B. Each and every item of the Fire Alarm System shall be listed under the appropriate category by a Nationally Recognized Testing Laboratory and shall bear the respective "NRTL" label.

1.08 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
- B. Notify Architect no fewer than two days in advance of proposed interruption of fire-alarm service.
- C. Do not proceed with interruption of fire-alarm service without Architect's written permission.

1.09 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

PART 2 - PRODUCTS

2.01 ACCEPTABLE EQUIPMENT AND SERVICE PROVIDERS

- A. Manufacturers: The equipment and service described in this specification are those supplied and supported by Johnson Controls and represent the base bid for the equipment.
- B. Subject to compliance with the requirements of this specification, provide products by one of the following:
 - 1. Simplex, a Johnson Controls Company

2.02

SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
1. Manual stations.
 2. Heat detectors.
 3. Smoke detectors.
 4. Duct smoke detectors.
 5. Verified automatic alarm operation of smoke detectors.
 6. Automatic sprinkler system water flow.
 7. Fire-extinguishing system operation.
- B. Fire-alarm signal shall initiate the following actions as required:
1. Continuously operate alarm notification appliances.
 2. Identify alarm at fire-alarm control unit and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Unlock electric door locks in designated egress paths.
 5. Release fire and smoke doors held open by magnetic door holders.
 6. Activate voice/alarm communication system.
 7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 8. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
 9. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 10. Recall elevators to primary or alternate recall floors.
 11. Activate emergency lighting control.
 12. Activate emergency shutoffs for gas and fuel supplies.
 13. Record events in the system memory.
 14. Record events by the system printer.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. Low-air-pressure switch of a dry-pipe sprinkler system.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of primary power at fire-alarm control unit.
 4. Ground or a single break in fire-alarm control unit internal circuits.
 5. Abnormal AC voltage at fire-alarm control unit.
 6. Break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at fire-alarm control unit or annunciator.
 9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
- E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer where provided.

2.03 ADDRESSABLE INITIATING

A. ADDRESSABLE MANUAL PULL STATIONS

1. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
2. Description: Addressable single action type, red LEXAN. Station shall mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units. Station shall be pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit. Where double-action stations are provided, the mechanism shall require two actions push top activation door to initiate an alarm.
3. Provide with a front showing red LED showing that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the station LED shall be on steady.
4. Indoor Protective Shield: Where required, or as indicated on the drawings, provide a factory-fabricated, tamperproof, clear LEXAN enclosure shield and red frame that easily fits over manual pull stations which shall be hinged at the top to permit lifting for access to initiate a local alarm. Unit shall be NRTL listed.

B. ADDRESSABLE ANALOG SMOKE SENSORS

1. General Requirements for System Smoke Detectors:
 - a. Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
 - b. Factory Nameplate: Serial number and type identification.
 - c. Operating Voltage: 24 VDC, nominal and shall be two-wire type.
 - d. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
 - e. Each sensor base shall contain a magnetically actuated test switch to provide for easy pre-certification alarm testing at the sensor location.
 - f. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
 - g. Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit. Provide multiple levels of detection sensitivity for each sensor.
 - h. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACP.
 - i. The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI. Removal of the sensor head for cleaning shall not require the setting of addresses.
 - j. Bases: CO Sensor, relay output, sounder and isolator bases shall be supported alternatives to the standard base.

2. Addressable Sensor Bases
 - a. Standard base - Twist lock addressable base with address selection DIP switch accessible from front with sensor removed. Integral red LED for power-on (pulsing), or alarm or trouble (steady on). Locking anti-tamper design mounts on standard outlet box.
 - b. Sensor Base with remote device connection - All standard base features with wired connection for either a Remote LED alarm indicator or remote relay (relay is unsupervised and requires separate 24VDC)
 - c. Supervised Relay Bases - All standard base features and shall be available in either a 4-Wire Sensor Base to use with remote or locally mounted relay; requires separate 24 VDC, or as a 2-Wire Sensor Base to use with remote or locally mounted relay; no separate power required. Supervised relay operation shall be programmable and shall be manually operated from control panel.
 - d. Sensor base with built-in electronic alarm sounder - All standard base features and piezoelectric sounder shall provide high output (88 dBA) with low current requirements (20 mA). Sounder shall be synchronized via SLC communications or by the NAC if NAC powered, sounder shall operation shall be programmable and shall be manually operated from control panel.
 - e. 520 Hz Sensor base with built-in electronic low frequency sounder - All standard base features and piezoelectric sounder shall provide a low frequency 520 Hz Square Wave (85 dBA) with nominal current requirements (115 mA). Sounder shall be synchronized via SLC communications or by the NAC if NAC powered, sounder operation shall be programmable and shall be manually operated from control panel.
 1. Emitted tone shall be a 520Hz Square Wave signal in compliance with the requirements of the 2010 edition of NFPA 72 for sleeping areas.
 2. The 520Hz Sounder base shall be listed to UL 268 and UL464, Audible Signal Appliances.

C. ADDRESSABLE DUCT SMOKE SENSOR

1. Standard Addressable Duct Smoke Sensor Unit. Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Duct housing shall include relay or relay driver as required for fan shutdown.
 - a. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACP.
 - b. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable independent of the sensor head for activation by other alarm initiating devices within the fire alarm system. Relay shall be mounted within 3 feet of HVAC control circuit.
 - c. Duct Housing shall provide a magnetic test area and Red sensor status LED and Duct Housing shall provide a relay control Yellow LED trouble indicator.
 - d. Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
 - e. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
 - f. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.

- g. Each duct smoke sensor shall be provided with a Remote Test Station with an alarm LED and test switch.
 - h. Where indicated provide a NEMA 4X weatherproof duct housing enclosure that shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.
2. Addressable In-Duct Mounted Smoke Sensors. Photoelectric type, for applications with controlled dust and humidity providing HVAC duct smoke sensing where sampling tube designs are not appropriate. In-Duct housing shall include relay or relay driver as required for fan shutdown.
- a. Shall accommodate duct airflow from 0 to 4000 ft/min (0 to 1220 m/min), and provide environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor by the FACP.
 - b. The In-Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable independent of the sensor head for activation by other alarm initiating devices within the fire alarm system. Relay shall be mounted within 3 feet of HVAC control circuit.
 - c. Standard models shall be for rectangular ducts from 6" (152 mm) square to 36" (914 mm) square with optional adapters available to allow use with round ducts of 6", 8" (203 mm), 10" (254 mm) or 12" (305 mm) in diameter.
 - d. In-Duct Housing shall provide a magnetic test area and Red sensor status LED and In-Duct Housing shall provide a relay control Yellow LED trouble indicator.
 - e. Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
 - f. Each duct smoke sensor shall be provided with a Remote Test Station with an alarm LED and test switch.
3. Addressable Air Aspirating Duct Smoke Sensors. Photoelectric type smoke detection with an aspirating system shall provide remote sensor location for ducts with difficult service access. Detectors shall support remote housing up to 82ft with 1.05" OD rigid pipe; detectors shall support remote housing up to 50ft with 3/4" OD flexible tubing. Sampling tubes shall be provided per design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Duct Detection system shall be UL listed to Standards 268A, and ULC listed to Standard S529.
- a. Environmental compensation, programmable sensitivity settings, status testing and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACP.
 - b. The Air Aspirating duct detection system shall supervise air flow through the duct housing and shall communicate trouble to the fire alarm control unit on a high or low air flow condition.
 - c. The Air Aspirating Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single Form C contact rated at 7A@ 28VDC and 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
 - d. Air Aspirating Duct Housing shall provide a magnetic test area and Red sensor status LED.
 - e. Each duct smoke sensor shall have a Remote Test Station with an alarm LED and test switch.
 - f. Each duct housing shall have remote functional smoke testing capability.
 - g. Each duct housing shall be supplied with a replacement air inlet filter.

- h. Each duct housing shall have an optional water trap with a ball valve for draining to eliminate moisture buildup.
- i. The Air Aspirating Detection system shall have an operating air velocity range of 0 to 4000 linear ft/minute) 0 to 1220 meters/minute.
- j. The Addressable Air Aspirating Detection system shall be capable of use in other areas as open area detection where point type detectors are not practical, such as; prison cells in correctional facilities, transformer vaults, cable tunnels and MRI rooms.

D. ADDRESSABLE HEAT SENSORS

- 1. General Requirements for Heat Detectors: Comply with UL 521.
- 2. Thermal Sensor Combination type: Fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; Actuated by either a selected fixed temperature or a rate of rise that exceeds a preset amount per minute unless otherwise indicated.
- 3. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag. Selectable rate compensated, fixed temperature sensing with or without rate-of-rise operation.
- 4. Mounting: Twist-lock base interchangeable with smoke-sensor heads.
- 5. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- 6. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 135-deg F or 155-deg F Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.
- 7. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.
- 8. Unless otherwise indicated, sensors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for temperature by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit
 - c. The CO Sensor shall be an addressable carbon monoxide (CO) sensing module providing both CO toxic gas detection and enhanced fire detection, and shall be listed to UL 268, Smoke Detectors for Fire Alarm Signaling Systems and UL 2075, Gas and Vapor Detectors and Sensors; allowing systems to be listed to UL 2034, Single and Multiple Station Carbon Monoxide Alarms.
 - d. The CO Sensor shall include CO sensor element mounted in the sensor base which can be easily replaced without replacing the complete sensor base assembly.
 - e. The CO Sensor base shall provide address selection in the base allowing the address to remain with its location when the sensor is removed for service or type change.
 - f. The CO Sensor base shall include an integral red LED to indicate the power-on, trouble, test mode or alarm status.

- g. CO sensor shall provide enhanced fire detection with the addition of two selectable modes of operation: Nuisance Alarm Reduction Mode and Faster Fire Detection.
 - h. The CO Sensor shall provide a 10-year life expectancy before replacement is necessary or required.
 - i. The CO Sensor base shall report the following CO Sensor troubles: Communication loss, Disabled, Almost Expired 12 Months, Almost Expired 6 Months, Expired (End of Life), and Sensor Missing/Failed.
9. Addressable CO Sensor Sounder Base
- a. The CO Sensing element shall support operation with a Sounder base; the CO Sensor Sounder base shall provide temporal code 3 (TC3) for fire, or temporal code 4 (TC4) for toxic carbon monoxide alarms.
 - b. The CO Sensor Sounder base shall be listed to UL464, Audible Signal Appliances.
 - c. CO sensor shall provide enhanced fire detection with the addition of two selectable modes of operation: Nuisance Alarm Reduction Mode and Faster Fire Detection.
 - d. The CO Sensor Sounder Base shall include CO sensor element mounted in the sounder base which can be easily replaced without replacing the complete sensor base assembly.
 - e. The CO Sensor Sounder base shall provide address selection in the base allowing the address to remain with its location when the sensor is removed for service or type change.
 - f. The CO Sensor Sounder Sensor base shall include an integral red LED to indicate the power-on, trouble, test mode or alarm status.
 - g. The CO Sensor Sounder base shall report the following CO Sensor troubles: Communication loss, Disabled, Almost Expired 12 Months, Almost Expired 6 Months, Expired (End of Life), and Sensor Missing/Failed.
 - h. The CO Sensor Sounder Base shall be interchangeable with the CO Sensor 520 Hz Sounder Base.
10. Addressable CO Sensor 520 Hz Sounder Base
- a. The CO Sensing element shall support operation with a 520 Hz Sounder base; the 520 Hz CO Sounder base shall provide temporal code 3 (TC3) for fire, or temporal code 4 (TC4) for toxic carbon monoxide alarms.
 - b. Emitted tone shall be a 520Hz Square Wave signal in compliance with the requirements of the 2010 edition of NFPA 72 for sleeping areas.
 - c. The CO Sensor 520Hz Sounder base shall be listed to UL 268 and UL464, Audible Signal Appliances.
 - d. CO sensor shall provide enhanced fire detection with the addition of two selectable modes of operation: Nuisance Alarm Reduction Mode and Faster Fire Detection.
 - e. The CO Sensor 520 Hz Sounder Base shall include CO sensor element mounted in the sounder base which can be easily replaced without replacing the complete sensor base assembly.
 - f. The CO Sensor 520 Hz Sounder base shall provide address selection in the base allowing the address to remain with its location when the sensor is removed for service or type change.
 - g. The CO Sensor 520 Hz Sounder base shall include an integral red LED to indicate the power-on, trouble, test mode or alarm status.
 - h. The CO Sensor 520 Hz Sounder base shall report the following CO Sensor troubles: Communication loss, Disabled, Almost Expired 12 Months, Almost Expired 6 Months, Expired (End of Life), and Sensor Missing/Failed.
 - i. The CO Sensor 520 Hz Sounder Base shall be interchangeable with the standard CO Sensor Sounder Base.

E. ADDRESSABLE MULTI-POINT/MULTI-SENSOR/MULTI-CRITERIA SENSOR

1. Smoke and heat sensing shall be available to be combined in a single housing to provide smoke activity accurately monitored by photoelectric sensing technology and thermal activity accurately monitored by thermistor sensing technology.
2. A correlation algorithm of smoke activity and thermal activity shall be provided for intelligent fire detection earlier than with either technology activity alone but shall provide software and programming capabilities to help reduce nuisance alarms.
3. Individual sensor information shall be processed by the host fire alarm control unit to determine sensor status and to determine whether conditions are normal, off-normal, or alarm.
4. Analog information from each sensor type shall be digitally communicated to the control panel where it is to be analyzed. Photoelectric sensor input is to be stored and tracked as an average value with an alarm or abnormal condition being determined by comparing the sensor's present value against its average value. Thermal data is to be processed to look for absolute or rate-of-rise temperature as desired.
5. Monitoring each photoelectric sensor's average value shall provide a software filtering process that compensates for environmental factors (dust, dirt, etc.) and component aging, which shall provide an accurate reference for evaluating new activity. The intent of this process is to be a significant reduction in the probability of false or nuisance alarms caused by shifts in sensitivity, either up or down. Status indications of dirty and excessively dirty shall be automatically generated allowing maintenance to be performed on a per device basis.
6. Peak activity per sensor shall be stored by the host fire alarm control unit to assist in evaluating specific locations where the alarm set point for each sensor shall be capable of being determined at the control panel, and selectable as more or less sensitive as the individual application requires.
7. Alarm set points shall be programmed for timed automatic sensitivity selection (such as more sensitive at night, less sensitive during day). Control panel programming shall also provide multi-stage operation per sensor, for example a 0.2% level may cause a warning to prompt investigation while a 2.5% level may initiate an alarm.
8. Combination smoke and heat sensors Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute. The fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
9. Bases: CO Sensor, relay output, sounder, 520 Hz Sounder, and isolator bases shall be supported alternatives to the standard base.
 - a. Air Sampling Pipe Network: Shall consist of a ¾ inch nominal inside diameter pipe arranged to provide optimal efficiency and air transport times which shall not exceed 60 seconds from the furthest point on the network. Sampling points shall be separated at intervals specified in NFPA 72; not more than 30 feet and typically in the range of 13 to 26-foot intervals along the path of the piping network. Air sampling calculations shall be provided from a registered VESDA sampling pipe aspiration modeling program ASPIRE rev.2.04 or later.

10. High Level Interface: Where VESDAnet is used, provide compatible fire alarm control unit interface module integral to the Fire Alarm Control Unit with connection to the High-Level Interface Module and installed in the VESDAnet equipment rack assembly.

2.04 NOTIFICATION

- A. Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:
 1. The maximum pulse duration shall be 2/10 of one second.
 2. Strobe intensity shall meet the requirements of UL 1971.
 3. The flash rate shall meet the requirements of UL 1971.
- B. Horn/Strobes:
 1. Operate on 24 VDC.
 2. Have (2) selectable tone options of temporal (3) and non-temporal continuous pattern.
 3. Have at least (2) audibility options.
 4. Maximum Pulse Duration: 0.2 second.
 5. Strobe Intensity: UL 1971.
 6. Flash Rate: UL 1971
 7. Strobe Candela Rating: Determine by positioning selector switch on back of device.

2.05 MAGNETIC DOOR HOLDERS

- A. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develop a minimum of 25 lbs. holding force.
- B. Material and Finish: Match door hardware.

2.06 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 1. Factory fabricated and furnished by manufacturer of device.
 2. Finish: Paint of color to match the protected device.

PART 3 – EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

- B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
 - 1. Factory trained and certified personnel.
 - 2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
 - 3. Personnel licensed or certified by state or local authority.

3.02 EQUIPMENT INSTALLATION

- A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, Ethernet drops, and all other necessary material for a complete operating system.
- B. Existing Fire Alarm Equipment shall be maintained fully operational until the new equipment has been tested and accepted.
- C. Equipment Removal: After acceptance of the new fire alarm system, disconnect and remove the existing fire alarm equipment and restore damaged surfaces. Package operational fire alarm and detection equipment that has been removed and deliver to the Owner. Remove from the site and legally dispose of the remainder of the existing material.
- D. Install manual station with operating handle 48 inches (1.22 m) above floor. Install wall mounted audible and visual notification appliances not less than 80 inches (2.03 m) above floor to bottom of lens and not greater than 96 inches (2.44 m) above floor to bottom of lens.
- E. Mount outlet box for electric door holder to withstand 80 pounds pulling force.
- F. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, fire suppression system control units, duct smoke detectors .
- G. Automatic Detector Installation: Conform to NFPA 72.

3.03 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
 - 2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
 - 3. Smoke dampers in air ducts of designated air-conditioning duct systems.

4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
9. Supervisory connections at elevator shunt trip breaker.
10. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
11. Supervisory connections at fire-pump engine control panel.

3.04 WIRING INSTALLATION

- A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).
- B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
- C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

3.05 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.06 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
 1. Factory trained and certified.
 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
 3. International Municipal Signal Association (IMSA) fire alarm certified.
 4. Certified by a state or local authority.
 5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
- C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.

- D. Inspection:
1. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
 2. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.
- E. Acceptance Operational Tests:
1. Perform operational system tests to verify conformance with specifications:
 - a. Each alarm initiating device installed shall be operationally tested. Each device shall be tested for alarm and trouble conditions. Contractor shall submit a written certification that the Fire Alarm System installation is complete including all punch-list items. Test battery operated emergency power supply. Test emergency power supply to minimum durations specified. Test Supervising Station Signal Transmitter. Coordinate testing with Supervising Station monitoring firm/entity.
 - b. Test each Notification Appliance installed for proper operation. Submit written report indicating sound pressure levels at specified distances.
 - c. Test Fire Alarm Control Unit and Remote Annunciator.
 2. Provide minimum 10 days notice of acceptance test performance schedule to Owner, and local Authority Having Jurisdiction.
- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Use NFPA 72 Forms for documentation.
- H. Final Test, Record of Completion, and Certificate of Occupancy:
1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy. Provide completed NFPA 72 Record of Completion form to Owner and AHJ.

3.07 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

END OF SECTION 28 3111

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this section.

1.2 GENERAL

- A. Security Systems include IP security cameras.
- B. The Owner will purchase all equipment directly from Securitas, Securitas will furnish approved submittals to the contractor.
- C. The contractor shall provide power and category 5E and other backbone cables for the systems.
- D. The contractor shall provide all back boxes and raceways required for the systems.
- E. Securitas will provide all system programming and head end hardware.
- F. The contractor shall assist Securitas and their certified installer with testing and commissioning the system.
- G. The certified installer shall make all terminations and mount devices on backboxes provided by the contractor.
- H. The contractor shall coordinate all work with:
Mr. Andy O'Reilly
518-376-6604
Andy.OReilly@securitas.com

1.3 SCOPE OF WORK

- A. The contractor shall provide the following:
 - 1. Remove the existing security equipment, box and turn over to Securitas for storage.
 - 2. Provide category 5E cables from the closest IDF to each security camera. Provide a lightning arrestor for all exterior cameras.
 - 3. Maintain record drawing of any wiring installation that deviates from shop drawing submittal. The contractor shall assist Securitas technicians with testing and certifying the security systems.

1.4 REFERENCES

- A. Underwriter's Laboratories UL-1069 current release
- B. NFPA – National Fire Protection Association
- C. NEC – National Electrical Code - NFPA 70 and 99
- D. ADA – Americans with Disabilities Act
- E. EIA – Electronic Industry Association
- F. NEMA – National Electrical Manufacturers Association – Installation Standards
- G. U.S. Dept. of Labor / Occupational Safety and Health Administration
- H. State Hospital Code / Joint Commission of Hospitals – Nurse Call
- I. Canadian Standards Association

1.5 SUBMITTALS

- A. Securitas will submit the following to the contractor and the engineer. The submittals will be furnished according to Conditions of Contract and Division 1 Specification Sections
 - 1. Product Data for each type of device and all equipment.
 - 2. Riser diagrams showing all devices and equipment.
 - 3. Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.
 - 4. Wiring Diagrams: Power, signal, and control wiring.
 - 5. Station Installation Details: For built-in equipment; dimensioned and to scale.
 - 6. Equipment Cabinet Drawings: Dimensioned and to scale.
 - 7. Manufacturer Certificates: Signed by manufacturers certifying that nurse call equipment complies with requirements.
 - 8. Manufacturer's Warranty Statement.
 - 9. Field Tests Reports and Observations: Include record of final adjustments certified by Installer.
 - 10. Operation and Maintenance Data:
 - a. Operating instructions.
 - b. Troubleshooting guide.
 - c. Wiring diagrams and terminal identification.
 - d. Equipment parts list.
 - e. Product data for types and sizes of wires and cables used.

- B. The contractor shall provide the following submittals. The submittals will be furnished according to Conditions of Contract and Division 1 Specification Sections
 - 1. Provide certification that all submittals have been received from Securitas and that they are complete and there are no questions

1.6 WARRANTY

- A. The installing manufacturer's representative shall guarantee all labor, parts, and installation for a period of 1 year from substantial completion or first beneficial use of the system.
- B. The contractor shall warrantee all Category 5 cable for a period of 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Securitas will furnish products from the Manufacturers:
- B. IP Security Cameras and servers – Axis Communications

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wiring Method: Install wiring in raceway at door location and in open top cable hangers above accessible ceilings.
 - 1. Pull cables simultaneously if more than one is being installed in same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips that will not damage media or raceway. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.
- B. Wiring within Enclosures: Provide adequate length of conductors.
- C. Separation of Wires: Run in separate raceways or, if exposed or in same enclosure, provide 12-inch minimum separation between conductors and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.
- D. Identification of Conductors and Cables: Retain color-coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams. Label stations, controls, and indications using approved consistent nomenclature.

- E. Category-5 or better wire termination will be connectorized according to ANSI Standard T568A. Grounding Provisions: Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. A factory-authorized service representative will inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Test Procedure: Comply with the following:
 - 1. Schedule tests a minimum of seven (7) days in advance of performance of tests.
 - 2. Report: Submit a written record of test results.
 - 3. Operational Test: Perform an operational system test, and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and all-call messages and pages at each nurse call station. Verify proper call-in routing and volume levels for each intercom station.

3.3 DRAWINGS

- A. Provide as built drawings of all installed network components and associated wiring on building plans. Final payment for work will not be authorized unless these drawings are supplied.

END OF SECTION 284112